SPEKTRUM OCH TERMANALYS AV FOSFOR I

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AV

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F Ö R O R D

1. ATOMFYSIK

Atomfysik benämns det område av fysiken som behandlar den yttre delen av atomen. En atomfysiker undersöker alltså de elektroner som omger kärnan och växelverkar med varandra. En utomstående iakttagare kan naturligtvis frestas att betrakta den här grenen på det vetenskapliga trädet som ett föga fruktbärande och praktiskt givande utskott. Det visar sig emellertid att ett stort antal fysikaliska företeelser i naturen måste beskrivas på atomär nivå om tillfredställande modeller av dessa fenomen skall kunna formuleras. Sådana modeller är nödvändiga för tillämpad forskning i synnerhet det tekniska utvecklingsarbetet.

Elektronerna i atomen kan enbart anta vissa bestämnda energivärden. Dessas antal är egentligen oändligt, men i allmänhet är det tillräckligt att bestämma ett visst antal av dem för att de övriga sedan med tillräcklig noggranhet skall kunna beräknas. Opåverkade antar elektronerna de lägsta energinivåerna i den ifrågavarande atomen, men kan om energi tillförs uppnå högre liggande nivåer, från vilka de i regel inom en mycket kort tidsperiod (miljondelar av en sekund eller mindre) återgår till grundtillståndet under utsändande av elektromagnetisk

strålning. Atomerna har alltså förmåga både att uppta och avge energi i form av sådan strålning. Med hjälp av elektriska ljuskällor exciteras atomen och bringas att utsända ljus eller strålning som sedan i ett instrument, en s.k. spektrograf delas upp i våglängder och registreras, antingen fotografiskt eller fotoelektriskt. De uppmätta våglängderna svarar var och en mot en viss bestämnd energi och genom analys av det erhållna experimentella resultatet kan det komplicerade samspelet i atomens elektronhölje kartläggas, dvs nivåernas energilägen bestämmas och likaså deras egenskaper.

Några exempel kan här anges där atomfysiken eller närmare bestämt en mera begränsad del av denna, nämligen atomspektroskopin, lämnar viktiga bidrag till lösandet av uppkomna problem.

Astronomin är i sitt studium av världsrymden hänvisad till att undersöka den strålning som infaller mot jorden. Vid analys visar den sig till stor del utgöras av de linjespektra som olika grundämnen avger. För att kunna kartlägga de fysikaliska egenskaperna hos himlakropparna, som t.ex. täthet, temperatur, grundämnenas inbördes sammansättning osv. är alltså en noggran kännedom om atomernas elektronstruktur nödvändig.

Stimulerad emission kan åstadkommas genom att en högre energinivå i en atom fås att bli kraftigare populerad än en lägre. Man kan då under vissa betingelser erhålla ett parallellt, monokromatiskt och koherent strålknippe. På så sätt har den s.k. lasern konstruerats, vilken kommit till användning i de mest skiftande sammanhang. Atomfysiken har alltså här lämnat ett viktigt bidrag.

På 1970-talet har på ett särskilt sätt jordens begränsade energiresurser aktualiserats. Den energi som härvid avses är den som krävs för att vi skall kunna upprätthålla vårt dagliga liv; värme till bostäder, elenergi, drivmedel till bilar osv. En energikälla som i det sammanhanget har betraktats som speciellt attraktiv är den s.k. fusions- eller vätereaktorn. Praktiskt taget oändliga energimängder finns magasinerade i världshaven och avfallet från en fungerande väteenergikälla är ansett som tämligen riskfritt - åtminstone jämfört med det som levereras från dagens konventionella uranreaktor. Problemet att få en fungerande sådan anordning har emellertid visat sig vara svårlöst. Flera tekniska problem har tillstött och varit synnerligen svårbemästrade, bl.a. förekommer "sputtering effects" i väggarna. Väteplasmat omges av ett kärl från vars väggar atomer slås ut, hamnar i urladdningen och nedsätter dess effektivitet. I plasmat finns då joner av olika laddning. Atomspektroskopin kan här genom studiet av jonerna i plasmat förklara processen och lösa ett problem som hotar att omintetgöra utnyttjandet av hela denna energiform.

2. AVHANDLINGEN

Den föreliggande avhandlingen, som kommer att publiceras i Physica Scripta, redovisar resultatet av studiet av den neutrala fosforatomens spektrum och upprättandet av dess termschema och bär titeln

The Spectrum and Term Analysis of Phosphorus I.

När man med hjälp av en lämplig ljuskälla exciterar det spektrum man eftersträvar, krävs i allmänhet att ämnet först har förångats. Studiet av den neutrala fosforatomens spektrum kompliceras i hög grad av att fosfor i ångform består av fyratomiga molekyler. En ändamålsenlig ljuskälla skall alltså både dissociera molekylen och frambringa atomspektret. En ljuskällas effektivitet härvidlag kan uttryckas i signal/brus förhållandet, dvs. atomlinjernas styrka i förhållande till intensiteten hos bandspektrum.

Fosfor förekommer i naturlig form i olika modifikationer med olika ångtryck. I urladdningen befinner sig fosforn i gasform men kan övergå i fast form vid det omgivande rörets väggar. Ångan härrörande från en viss modifikation antar då en ny sådan beroende på den temperatur som väggen har. Man kan på så sätt få olika fosfortyper med olika ångtryck samtidigt närvarande i ljuskällan, vilkas inbördes sammansättning ibland drastiskt ändras. Urladdningens stabilitet beror till stor del på totaltrycket, vilket ställer stora krav på en fungerande anordning.

Den ljuskälla som uppvisar de bästa egenskaperna i detta avseende har visat sig vara en pulsad högfrekvensurladdning. Den har använts vid undersökning av både P I spektrum (det aktuella arbetet) och P II spektrum (kommer att publiceras senare) Genom att höja fosforångans tryck har P I favoriserats och tyvärr också molekylbandspektrum, och omvänt har genom sänkning av trycket P II gynnats. Detta ger också möjlighet att avgöra, vilket spektrum olika linjer tillhör.

I vakuumområdet 1100-2700 Å har ca 450 P I linjer uppmätts och klassifierats och i luftområdet 4000-11500 Å är motsvarande

antal omkring 900. I det utomfotografiska infraröda området användes ett mikrovågsrör som ljuskälla och 550 linjer har här klassificerats. Denna del av undersökningen utfördes vid Laboratoire Aimé Cotton, Orsay, med en Fourier-transform-spektrograf. I denna passerar ljuset en interferometer, vars ena spegel är rörlig och registreras sedan av en blysulfid-detektor. Metoden medger upptagning av ett spektrums infraröda del på några få timmar. Upplösningen kan göras mycket god och den bästa av de upptagningar som presenteras i föreliggande arbete medger en sådan av 0.007 cm^{-1}. Omkring 200 hyperfin-strukturer i P I har observerats och uppmätts. Dessa kommer visserligen att publiceras i ett senare arbete, men har redan i föreliggande analys använts för att ge de funna nivåerna adekvata beteckningar.

Våglängdslistan omfattar totalt ca 2000 linjer, varav 95% är klassificerade.

Termsystemet i P I är uppbyggt av konfigurationer av typen $3s^2 3p^2 nl$. Föräldratermerna ^3P, ^1D och ^1S, vilka härleds från de två p-elektronerna, har ett inbördes avstånd av 8900 cm^{-1} respektive 12700 cm^{-1}. Den lägsta jonisationsgränsen är belägen 84580 cm^{-1} över grundtillståndet och den lägsta termen i övre delen av systemet $(^3P)4s\ ^4P$ 56000 cm^{-1}, totalt ett energiavstånd av ca 29000 cm^{-1} som de 277 etablerade nivåerna - förutom de fem grundnivåerna - befinner sig inom. Ett flertal termer som bygger på ^1D har etablerats och ligger delvis blandade med andra konfigurationer $(^3P)nl$, på vars termer de verkar kraftigt störande. Analysen skulle emellertid ha varit

tämligen lätthanterlig såvida inte $3s3p^4$ funnits med i bilden. Konfigurationens fyra termer ^4P, ^2D, ^2P och ^2S finns utspridda inom ett område som sträcker sig från 4s ^4P till ovanför första gränsen. Växelverkan med nivåerna i nd-serien, som ju har samma paritet, är mycket kraftig. I konfigurationer som innehåller oparade s-elektroner har de enskilda nivåerna stor hyperfinstruktursuppspaltning. Med hjälp av mätningarna i Fourierspektrografen har det sålunda varit möjligt att definitivt fastställa vilka som tillhör $3s3p^4$. Av dessa har ^4P och ^2D, som ligger under den första jonisationsgränsen, kunnat fastläggas.

Vid analys av högjoniserade spektra är isoelektroniska jämförelser till stort gagn. Vid undersökning av neutrala spektra visar det sig däremot ofta att några avgörande slutsatser inte kan dragas på basis av isoelektroniska diagram. Förutom de rent experimentella fakta som föreligger är man här istället i större utsträckning hänvisad till kvantmekaniska beräkningar. Samtliga konfigurationstyper som förekommer i den neutrala fosforatomens elektronstruktur, nedanför den första jonisationsgränsen har undersökts teoretiskt, vilket avsevärt bidragit till att förbättra analysen.

I synnerhet har den sammansatta konfigurationen $3s3p^4+3d+4d+5d$ varit föremål för studium. De elektrostatiska och magnetiska parametrarna har anpassats till de observerade nivåerna. För att få en godtagbar utjämning med rimliga värden på parametrarna har de tre nivåerna i termen 3d ^4P uteslutits i anpassningen. Inkluderas fler parametrar kan visserligen de avvikelser, som uppkommer om 3d ^4P medtas, fås att minska, men detta ger ingen klarare bild av växelverkningarna. För att

ett tillfredsställande resultat skall uppnås krävs en mera omfattande teoretisk behandling.

Våglängdslistan innehåller omkring 110 oklassificerade P I linjer. I vakuumområdet finns också ett antal sådana men de kommer att redovisas i P II arbetet. Ett flertal av dessa - åtminstone de starkaste - torde vara att hänföra till övergångar mellan nivåer högt uppe över jonisationsgränsen i systemet och från vilka inga anknytningar till den kända delen av termschemat kan förväntas. De högt liggande konfigurationerna $3s3p^3ns$, $3s3p^3np$ och $3s3p^3nd$ ger bland annat upphov till relativt kopplingsrena sextettermer vilka förmodligen kombinerar starkt inbördes.

Jag skulle vilja rikta ett varmt tack till alla dem som verksamt underlättat arbetet och bidragit till dess genomförande; Docent Ingmar Johansson, Docent Ulf Litzén, Professor Bengt Edlén, Professor Indrek Martinson och alla övriga kollegor och vänner vid institutionen.

THE SPECTRUM AND TERM ANALYS OF PHOSPHORUS I

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Abstract

The Spectrum and Term Analysis of Phosphorus I. Nils Svendenius, (Department of Physics, University of Lund, S-223 62 Lund, Sweden)

The spectrum of neutral phosphorus has been studied photographically at Lund with a pulsed high-frequency electrodeless-discharge in the regions 1100-2700 Å and 4000-11500 Å. The Fourier transform spectrograph at Laboratoire Aimé Cotton, Orsay, has been used for recording the region 10000-40000 Å with a microwave tube as a light-source. In all, 1800 P I transitions have been measured and classified.

A total of 282 levels, about 180 of which are new, have been established. The levels belong to the configurations

4s-9s, 3p-6p, 3d-9d, 4f-9f, and 6g in the $3s^2 3p^2 (^3P)nl$ system, to 4s, 5s, 4p, 3d of the $(^1D)nl$ system and to $(^1S)4s$. Of the configuration $3s3p^4$ the terms ^4P and ^2D are known while ^2P and ^2S, predicted to fall above the first ionization limit, are missing. The effects of the perturbations between $(^3P)nd$, sp^4 and $(^1D)3d$ have been studied by parametric calculations of the composite configuration $sp^4+3d+4d+5d$.

1. Introduction

Previous work on the spectrum of Phosphorus I has been carried out by C.C. Kiess (1), H.A. Robinsson (2) and W.C. Martin (3). The investigations by Kiess and Robinsson yielded 85 classified lines. Martin extended the knowledge of the spectrum by reporting 490 lines, of which he classified 385. His analysis included 98 even and 43 odd levels, and the ionization potential could be calculated from several series. The observations covered the vacuum region and the air region below 9000 Å. The important region 11500-9000 Å and the extraphotographic infrared region were not included. As a consequence the 3d configuration and some other terms, especially those built on the parent term ^1D and the levels of the f-series, were difficult to find.

The terms of the configuration $3s3p^4$ have a strong influence on the level structure in the P I sequence. In P I this configuration is expected to be spread over the whole excited system and it is of special interest to examine the conditions here.

A questionable result of Martins' analysis is that the distance $sp^4\ ^2P$ to $3d\ ^2P$ is only about 200 cm^{-1}, while the matrix which includes the sp^4 and $(^3P)nd$ configurations has large interaction integrals. The configurations (n+2)s and nd fall on top of each other, particularly the ^4P terms come very close, and it would be useful to calculate the magnitude of the perturbations and examine the coupling conditions. In addition, the large number of unclassified lines in Martin's list suggested that a new investigation of the spectrum including the infrared region might give important information.

When the present work started the term system of P I comprised the 4s, 5s and 6s configurations and some questionable 7s and 8s levels. The ground configuration $3s^2 3p^3$ as well as 4p and 5p were also known. In the d-series levels of 3d-7d had been found. Some levels were also proposed to belong to 4f and 5f. In addition to these levels, which originate from the parent term ^3P, the terms $(^1D)4s\ ^2D$, $(^1S)4s\ ^2S$, $(^1D)4p\ ^2D$, $(^1D)3d$ (except ^2G) and ^4P, ^2P and ^2D of $3s3p^4$ were reported. However, some of these levels have had to be rejected or given new assignments in the present investigation, leaving about a hundred unchanged. Several of the lines earlier classified as P I have turned out to be P II lines.

Martin used a hollow cathode with helium as carrier gas. He introduced yellow phosphorus into the discharge from a side tube. In spite of the important improvements of his experiments compared to the earlier investigations one could expect to find other light sources that would dissociate the phosphorus molecule to a larger extent and thus give a better signal to noise ratio.

It would be of advantage, also, to use a carrier gas giving more reference lines than helium. Martin used a separate light source for references and the optical system had to be very carefully arranged to avoid displacements between the lines from the reference source and the phosphorus source.

2. Experimental Equipment

2.1 The light source

The spectrum of neutral phosphorus has usually been considered difficult to excite. This is due to the existence of several modifications with different melting and boiling points and with different vapour pressure and to the fact that the phosphorus vapour is molecular. The vapour from one modification may turn to one of the others when it condenses, depending on the temperature of the walls of the light source. Therefore, the vapour pressure may suddenly change in the discharge causing the light source to burn unsteadily. Much effort was spent on making the discharge burn steadily in a mode favouring the atomic spectra of phosphorus and suppressing the molecular bands. Furthermore, a method of favouring P I at the cost of P II and vice versa was worked out to achieve good experimental discrimination of ionization stages.

There exist several phosphorus compounds which may seem to be suitable for use in a light source, but when examining them it turns out that pure phosphorus is the most convenient. Normally the phosphorus vapour molecule consists of four atoms, and this molecule does not dissociate in a hollow cathode to a high

extent. There is a need of a light source which efficiently splits the molecule and thus depresses the band spectrum, and which also gives a strong atomic spectrum. Several light sources were tested and the best result was obtained with a pulsed high frequency-discharge (Fig. 1) in an electrodeless quartz tube.

The power was supplied by a generator which produced an induction field at a frequency of 18 Mhz and a voltage of about 8 kV. The mean current was about 100 mA giving an effect of 800 W. An intermittent 100 Hz square wave was superposed on the 18 Mhz wave. The tube is surrounded by a coil, and they serve together as the induction component in a tunable resonance circuit. The induction depends on the total pressure and on the partial pressures of phosphorus vapour and carrier gas in the discharge tube.

The phosphorus was evaporated into the discharge tube by heating the container. At the beginning, when the phosphorus was in the yellow form, hot water was sufficient for heating but then, when it gradually turned into the red and black modification, a gas flame had to be used. Helium, neon and argon were used as carrier gases. Helium gives the largest intensity ratio of P II to P I, neon comes next and argon produces the smallest ratio. On the whole, neon gives the strongest excitation of both P I and P II, and helium splits the molecules most efficiently. In the air region between 11500 and 4000 Å it was useful to run the lamp with a mixture of all three gases. Helium suppresses the bands, and argon and neon give internal reference lines for the wavelength measurements.

Sometimes the tube was cooled by streaming air from a fan.

Increased cooling reduced the intensity of the P I lines and favoured the P II lines as well as the spectrum of the carrier gas. Reduced cooling increased the phosphorus pressure which favoured the band spectrum. Heating of the phosphorus container, cooling of the discharge tube and adjustment of the carrier gas pressure give good possibilities of controlling the excitation. Fig. 2 shows one exposure where the P II spectrum is enhanced and one exposure where the second spectrum is suppressed while the first spectrum and, inevitably, the bands are favoured.

When testing the discharge in order to get suitable and reproducible excitation conditions a Czerny-Turner mounted spectrograph for photoelectric detection in the extra photographic region was used (4). This apparatus registers instantly the variations in the discharge.

The discharge was run at a total rare-gas pressure of about 0.15 mm Hg, and a mercury diffusion pump forced the gas to circulate through a purifying liquid-nitrogen-cooled trap. To keep the front quartz window clean the current coil was extended so as to surround also this part of the tube, thereby making the temperature of the window high enough to prevent the phosphorus from condensing.

When taking the exposures in the vacuum-ultraviolet range the quartz tube was directly connected to the spectrograph without a window. To prevent clogging of the slit the coil-free front part of the tube was made somewhat longer to catch the condensing vapour. Also, some diaphragms were placed between the discharge and the slit. Argon and helium were used as carrier gases and were let into the light source through a needle valve

giving a suitable constant pressure in the discharge.

The phosphorus is a good hydrogen absorber. Hydrogen gradually accumulates on the solid phosphorus layer on the inner walls of the quartz tube and the circulating system. At higher temperatures it is emitted again producing a strong spectrum of hydrogen and the PH^- molecule. Small pieces of copper dioxide were therefore placed in a container in the system and electrically heated to produce oxygen which transforms the hydrogen to water vapour, the latter being caught in the cooled trap.

2.2 Spectrographs

In the air region, 11500-4000 Å, the spectrograms were taken in a 3 m Czerny-Turner instrument. The preferably used grating was a Bausch and Lomb replica blazed at 20000 Å and having a ruled area of 153x128 mm with 300 lines/mm. The arrangement gives a plate factor of 5.5 Å/mm in the second order. The large aperture shortens the exposure times which is of advantage especially in the region above 9000 Å, but the mounting does not produce well focused lines over the whole plate. The end parts of the plate are affected by coma aberrations and in higher orders the intensity due to the blaze drops off faster than in lower orders. Therefore, more overlapping plates had to be taken.

In the vacuum-ultraviolet range the exposures were made with a 3 m normal-incidence spectrograph. The replica grating is coated with MgF_2 and has a ruled area of 150x65 mm^2 with 1200 lines/mm. The plate factor is 2.77 Å/mm in the first order

where all lines in this part of the spectrum were measured

The investigation at ORSAY concerned the region 40000-9000 Å (5). The instrument was a Fourier transform spectrometer (FTS) which registers the signals from the light source by means of a PbS detector connected to an amplifying system. The aperture is high and the largest possible theoretical resolution is 0.005 cm^{-1}.

3. The wavelength measurements

3.1 The vacuum region

Recordings were made on Kodak SWR and Ilford Q2 plates in the first order. The lines have been measured on four spectrograms except for a few weak lines which were observed on only one spectrogram. The label MZ indicates that the wavelength value is taken from the list of Magnusson and Zetterberg (7). The line list contains 452 identified transitions (Table III).

The reference lines came mainly from impurity lines of O, N, C and S but also from Ar which was let into the discharge. The wavelength error for lines which are accepted in the calculation of the level system, does not exceed 0.012 Å for lines which have an intensity of 0 or larger, and 0.02 for weaker lines.

3.2 The air region

The exposures in the region 11500-4000 Å were taken on Kodak plates 103-O, 103a-F, I-N, I-M and I-Z. The sensitivity was increased for I-M and I-Z plates by hypersensitizing. The list contains 896 transitions (Table II). Some unclassified

P I lines are given in Table IV b.

The spectrograms above 8400 Å were taken in the second order with a plate factor of 5.4 Å/mm and an estimated error limit of ±0.03 Å, between 8400 Å and 5800 Å in the third order with a plate factor of 3.6 Å/mm and an uncertainty of ±0.015 Å, and below 5800Å in the fourth order with a plate factor of 2.7 Å/mm and an uncertainty of 0.01 Å.

Internal reference lines were taken mainly from the same order as the phosphorus spectra but, to get a sufficient number of references, some lines from other orders were also used. Some of the lines around 4000 Å, which were measured on one plate only, may have a somewhat larger uncertainty. The intensity estimates are based on a logarithmic scale with a base of about 1.4. The base was determined by comparing the intensities of the FTS lines with those estimated on the photographic exposures in the overlapping region. The scale is consistent, however, over limited regions only as no corrections for differences in plate sensitivity, spectrographic efficiency and recording conditions have been applied.

The observations by Martin have an upper limit at 8872 Å. The additional part of the photographic region, 8872-11500 Å, now investigated, contains many important transitions. More than 200 classified lines were detected here. Difficulties in obtaining well exposed reference lines have caused an uncertainty somewhat larger than ±0.03 Å for a few lines in this region.

3.3 The extraphotographic infrared region

Two separate recordings on the Fourier transform spectrograph have been used. One of them was recorded during three hours and covers the region 40000 Å to about 8500 Å, although the PbS detector is not very sensitive below 11000 Å and above 37000 Å. Photographic plates are more efficient below 11000 Å. The other spectrogram had a run of nine hours and covers the region between 40000 Å and 13700 Å. The signal to noise ratio is better and the theoretical resolution was increased to 0.007 cm^{-1} as compared to 0.025 cm^{-1} in the first recording. In the program output only the wavenumbers are given but corresponding wavelengths are included in the table to facilitate comparisons. 538 transitions were detected here (Table I). Unclassified P I lines are given in Table IV a.

The very high resolution makes it possible to resolve lines belonging to transitions between individual hyperfine levels. The lines which are marked in Table I with an H after the intensity figure consist of two and those marked with an H^1 of three hfs components. The centres of gravity are calculated and given in Table 1. Some transitions may contain only one of the hyperfine components, for example 12632.137 Å. The wavenumbers of the hfs components will be reported in a later publication (6).

The wavenumber error is estimated not to exceed 0.003 cm^{-1} for lines with an intensity figure of 5 or higher. For weaker lines the uncertainty may be considerably larger and for very weak lines it may be 0.02 - 0.03 cm^{-1}. The intensity figures were given by the same program as the wavenumbers.

As was pointed out above, the pulsed high-frequency discharge produces the best signal to noise ratio for the P I spectrum. However, the stability of the pulses is not good enough to permit this light source to be used together with the amplifying system of the FTS instrument. Therefore, a microwave tube, the only suitable, well tested light source available at Orsay, was used to excite the phosphorus spectrum. It is not possible to measure the total pressure in such a discharge under working conditions but the pressure seems to be high enough to cause observable displacements of some levels, the overlapping region between 11500 and 9000 Å being compared. Wether these displacements are to be explained as a general pressure effect or a Stark effect is difficult to determine. However, by comparing a set of relative level values, derived by using exclusively the FTS measurements, with a set obtained from the lines measured by means of the pulsed high-frequency discharge one finds, that the shift of a level depends both on its excitation energy and on the configuration.

4. The least squares fit of the energy level system

The level system is derived from the observed transitions by a least squares calculation using the program of Radziemski and Kaufman (8). Those lines, which have not been included in the fit are marked with a star in the line lists. The wavenumbers have been weighted according to their estimated uncertainty.

The energy values based on the transitions which are emitted by the pulsed high-frequency discharge are taken as the unshifted

(A) ones although their statistical errors are large compared to those from the microwave tube (B). The least squares fit where only the FTS lines are included gives a term system with an internal consistency better than 0.001 cm^{-1}. We thus have to apply systematic corrections to the FTS measurements. All levels in the same configuration are then supposed to be equally displaced. The mean value of the deviations for the levels of a given configuration is taken as the correction (A-B). Table V contains these corrections.

Since $(^3P)5s$ is not involved in the photographic infrared observations, the displacement of this configuration is obtained by assuming that the difference in shift between $(^3P)5s$ and $(^1D)5s$ is the same as between $(^3P)4s$ and $(^1D)4s$. For some configurations, where no correction is given, the number of lines in the extraphotographic region is too low to give an accurately calculated deviation. These lines are not incorporated in the least squares calculation of the term system. Since the statistical errors are not small compared to the systematic deviations some of the corrections have got positive sign, but the tendency is clear that the displacement increases with the n- and ℓ-quantum number. According to this trend it may be estimated that the energy levels of the 6g configuration, which have no transitions in the photographic region, are pushed upwards about 0.04-0.06 cm^{-1} in the microwave tube.

The correction of a given FTS wavenumber is obtained as the correction for the upper configuration minus the correction for the lower configuration. Comparing the column "calc." with the column "corr." in Table I, where the corrected wavenumbers are given, one finds that the correction is very small but not negligible. In the overlapping range 11500-9000 Å, the lines measured with the pulsed source and which

are also present in the FTS list, are used only when determining the corrections but not in the final least squares fit. They are also starred in the table.

The lower levels in the upper part of the system are very well connected mainly due to the FTS measurements. For example, the configuration 5s is tied to the other part of the system through 5s-5p, 5s-4p, 5s-4f and through the ground levels, which previously provided the only connection. The configuration 5p is connected to the ground configuration by the cycles 5p-5s-4p-4s-3p, 5p-3d-3p, 5p-sp^4-3p and by 5p-4s-3p.

In the level list (Table VI) values with three decimals are estimated to have a relative error not exceeding 0.005 cm^{-1}. Level values with estimated errors of 0.01 cm^{-1} to 0.05 cm^{-1} have two decimals. A few levels given with one decimal have an uncertainty of 0.2-0.4 cm^{-1}. For the levels of 6g the total uncertainty may be large depending on the light-source effect but since the relative error within the configuration is small the levels are given with three decimals. The ground levels are connected to the rest of the term system with an uncertainty of about 0.05 cm^{-1}.

5. Discussion of the configurations

5.1. Introduction

The level system of P I is based on the parent terms ^3P, ^1D and ^1S of the configuration $3s^2 3p^2$ (Fig. 3). By adding a 3p-electron the ground terms ^4S, ^2P and ^2D are obtained. The established part of the excited system is mainly built on the ^3P parent term. Of the levels originating from the parent term ^1D

those of the configurations 4s, 5s, 4p and 3d have been found, while those belonging to the f configurations and the higher memebers of the s-, p- and d-series will fall close to or above the first ionization limit ^3P and probably interact strongly with the continuum. Only one term, $4s^2S$, with parentage ^1S has been found. Other levels based on (^1S) are predicted to fall in the continuum above the first limit.

Of the sp^4 configuration only the established ^4P and ^2D fall below the first series limit. The electrostatic interaction integrals between the sp^4 configuration and the nd configurations are in magnitude comparable with the normal electrostatic integrals of these configurations (see Table VIII). Therefore, the only way to deal with the problem theoretically is to construct a composite configuration of sp^4 and nd. A sequence of computer programs constructed at Laboratoire Aimé Cotton (referred to as SUPRAC) (9) has been applied to the combined configurations sp^4, 3d, 4d and 5d. These configurations have the most important mutual interactions. If one should include still more configurations the number of parameters compared to the number of levels will become too large to be practically handled. The parameters in the matrices and the calculated levels are obtained in a least squares fit to the experimental levels.

The starting values of the integrals in the matrices were scaled Hartree-Fock values calculated in a program compounded by Froese-Fischer (10). The eigenvectors are evaluated in the LS-representation, and the program gives the coefficients of the LS-components of each level. In Table VII the three largest LS-components are included in the percentage composition.

In a separate diagonalization of the matrices the interaction integrals are omitted, while the values of the other parameters are the same as those of the fit. The positions thus obtained are plotted in Fig. 6 as the "unperturbed" positions.

The ns configurations also influence the nd and sp^4 configurations but the interactions ns <-> nd, and ns <-> sp^4 are significantly smaller than sp^4 <-> nd. Dr. Cowan has kindly provided calculations of the composite configurations $sp^4 + p^2 3d + p^2 4s$, $sp^4 + p^2 5s + p^2 6s$ as well as the configurations $p^3 + p^2 4p + p^2 5p$.

In Cowan's program E_{av} is estimated from the observations, and for the other integrals empirically scaled HF values (scaling factor 0.75-0.80) are used in the matrices which by diagonalization give the eigenvalues. A fit to the observed levels was not made, but the method describes the coupling conditions and predicts the size of the elements between the LS-functions, thus giving a good idea of the perturbations. This program and a connecting least-squares fit program has been applied on the f and g configurations.

5.2 The ns configurations.

The centroid diagram (Fig. 4) of the ^4P and ^2P terms of the s-series shows that with one exception there exist no drastic perturbations of this series; the exception, an increased term splitting of $7s^2P$, will be discussed together with the nd and sp^4 configurations. The value of the series limit ($^3P_2$) derived from $ns^4P_{5/2}$ (Table XIII) deviates by only about 2 cm^{-1} from that of

$(^3P_2)nf\ (5)_{11/2}$.

The terms (n+2)s ^4P fall close to nd ^4P (see Fig. 5) although their calculated undisturbed positions are far apart. According to Cowans calculation the mixing of n's ^4P + nd ^4P and n's ^2P + nd ^2P is not very large but the s-f transitions, about forty classified lines (4s, 5s) - (4f, 5f), must be due to a mixing of the wavefunctions of the s and d configurations. 5s ^4P and 3d ^4P come very close to each other, and the J = 3/2 levels are separated by just 80 cm^{-1}, but the theoretical calculation and the centroid diagrams make the designations seem to be clear. It is notable, however, that the transitions 5s $^4P_{3/2}$ - (4f,5f) are nearly as strong as 3d $^4P_{3/2}$ - (4f,5f). The strongest one $(^3P_1)nl\ ^4P_{3/2}$ - 4f (2)5/2 is even stronger to 5s than to 3d, intensity firgures 42 and 24. Fig. 4 illustrates the transition to jj-coupling when the series limit is approached.

There are several terms in the d-configurations that could disturb the $(^1D)ns\ ^2D$ terms, but the calculated non-diagonal matrix elements are small (Cowan). The observed term splitting, 0.8 cm^{-1} of (^1D) 4s ^2D and 6.1 cm^{-1} of (^1D) 5s ^2D, implies that any perturbations of the levels are not very important although even here transitions s-f exist.

The mixing $(^1S)4s\ ^2S_{1/2} + (^1D)3d\ ^2S_{1/2} + sp^4\ ^2S_{1/2}$ is strong and pushes down the level $(^1S)4s\ ^2S_{1/2}$, which is established by three strong lines in the vacuum region and a weak line in the air region.

5.3 The sp^4 and nd configurations

Fig. 6 shows the "unperturbed" positions, calculated by SUPRAC, in comparison with the observed positions of the terms of the configurations sp^4, 3d, 4d and 5d. A parameter fit which includes the term 3d ^4P produces large deviations ($E_{obs} - E_{calc}$) not only for levels of this term but also for a great number of other levels, especially those of 3d. Therefore, 3d ^4P is omitted in the parameter calculation, giving for this term a deviation $E_{obs}-E_{calc}$ of about 830 cm^{-1} in the final fit. This case would need a more comprehensive theoretical treatment than has been possible in the present work.

The strong mixing of the levels 4d $^2D_{3/2}$ and 4d $^4P_{3/2}$ is remarkable. The assignments follow the predominant component of the wavefunctions and are further supported by diagram (Fig. 7) and the transition arrays.

In the unperturbed positions, (^1D)3d $^3S_{1/2}$ falls below sp^4 $^2S_{1/2}$. Also (^1S)4s $^2S_{1/2}$ will interact strongly. The mixing of the three terms causes the term of sp^4 to be moved upwards and the two others downwards. The estimated non-diagonal elements are important. (^1S)4s $^2S_{1/2}$ is situated about 20100 cm^{-1} above (^3P)4s($^4P + ^2P$) which is 1200 cm^{-1} less than the interval 21300 cm^{-1} between the limits $3s^23p^2(^3P)$ - $3s^23p^2(^1S)$. The indicated downward shift is mainly due to (^1D)3d $^2S_{1/2}$, the unperturbed distance being just 3000 cm^{-1} and the repulsion parameter about 2000 cm^{-1} (Cowan). In the parameter fit, therefore, the experimental value of (^1D)3d $^2S_{1/2}$

is reduced by 1200 cm^{-1}. With this correction, smaller deviations (E_{obs}-E_{calc}) are obtained, but the values of the electrostatic integrals for sp^4, $G_1(sp)$ and $F_2(pp)$, which are partly determined by $(^1D)3d\ ^2S_{1/2}$, get large uncertainties. The calculation shows that the level $sp^4\ ^2S_{1/2}$ is moved to a position above the first ionization limit close to the $(^1D)nd\ ^2S_{1/2}$ continuum and may even be inside this continuum. It has not been possible to find the term.

As a consequence of the repulsion between sp^4 and nd, $sp^4\ ^2P$ is moved slightly upwards (2000 cm^{-1}) and the whole series nd ^2P is depressed. Of course, the large uncertainty of the parameters of sp^4 makes the calculated undisturbed position of $sp^4\ ^2P$ somewhat uncertain. However, the interaction parameters are so large that the repulsion from the two lowest members of the nd ^2P series is sufficient to cause $sp^4\ ^2P$ to fall above the limit.

The interval of $7s\ ^2P$ is increased from expected 300 cm^{-1} to about 450 cm^{-1}, which is evidently due to the fact that the three levels $(^1D)3d\ ^2P_{1/2}$, $(^1D)3d\ ^2P_{3/2}$ and $(^1D)3d\ ^2S_{1/2}$ happen to fall between the two components of $7s\ ^2P$. The estimated undisturbed splitting of $7s\ ^2P$ is about 300 cm^{-1} and that of $(^1D)3d\ ^2P$ about zero, the latter term being situated in the middle between the two components of $7s\ ^2P$. In the LS approximation scheme there are non-diagonal elements between $7s\ ^2P$ and $(^1D)3d\ ^2P$ but none between $7s\ ^2P$ and $(^1D)3d\ ^2S$. A Hartree-Fock calculation gives a value of the relevant interaction

parameter of approximately 150 cm^{-1}. By solving the secular equation corresponding to a 2 x 2 matrix we find that the observed repulsion effect (70 cm^{-1}) requires an interaction parameter of 130 cm^{-1}, which is close to the Hartree-Fock value. The term $(^1D)3d\ ^2P$ has an observed splitting of 130 cm^{-1}. When corrected, for the effect of the discussed perturbation, the splitting will be 0-30 cm^{-1}, which agrees well with that (18 cm^{-1}) from the SUPRAC calculation, where the interaction $(^1D)3d\ ^2P$ <—> $7s\ ^2P$ is not included.

The term $sp^4\ ^2P$ depresses the whole series $(^3P)nd\ ^2P$ and $(^1D)3d\ ^2P$ breaks the continuity between $5d\ ^2P$ and $6d\ ^2P$ (see Fig. 7). It was difficult to find the levels of the series with $n \geq 6$, due to the fact that the intensities of the lines from $(^3P)nd\ ^2P$ also changed in an unexpected way. Therefore, a diagonalization was carried out in order to analyze the interaction $nd\ ^2P$ <—> $(^1D)3d\ ^2P$ <—> $sp^4\ ^2P$ and to check if the parameters, which are needed to get the shifts, have a reasonable magnitude (see Table IX). The computation is carried out only for the series J = 3/2, of which six members are known, For sp^4, $(^1D)3d$ and $(^3P)nd$ (n=3-5) the matrix diagonal elements are taken as the calculated "unperturbed" positions (SUPRAC). Those of $(^3P)nd$ (n=3-5) are then plotted in a centroid diagram of the same kind as Figure 7. A straight line is fitted to the values in the diagram, and to the limit $3s^23p^2\ ^3P_1$. The obtained interpolated level values 6 for n=6,7 and 8 are then taken as input values in the matrix.

The integrals calculated from the least squares fit are used when constructing the non-diagnonal elements for n=3, 4, 5.

To get the interaction parameters (see Table IXa) which depend on $sp^4\ ^2p \leftrightarrow nd\ ^2P$ (n=6, 7, 8), the ratios between the matrix elements (2, 1) and (3, 1) and between (3, 1) and (4, 1) are determined and found to be approximately equal. The unknown elements in the first column are then obtained by assuming the same ratio also for them. The elements in the second column are evaluated by the same method as above, thus using the ratio between (2, 4) and (2, 5) to determine the other elements (2, 6), (2, 7) and (2, 8). Table IXb indicates that this procedure gives a reasonable picture of the perturbations.

Table X shows that the transitions $4p\ ^2S$ - $nd\ ^2P$ are the dominating ones up to n=5, whereas for n=6, 7 this is no longer the case. Table IXc also shows the character of the eigenfunctions. The functions which represent the input levels constitute the basis vector set. Studying the eigenvector of a calculated $nd\ ^2P$ level one finds, that the coefficient of the basis vector $(^1D)3d$ and the largest coefficient have opposite signs in the lower part of the series (n=3, 4, 5), and the same sign in the higher part (n=6, 7, 8), which may be the reason for the drastic drop in intensity of the transitions $4p\ ^2S_{1/2}$ - - $nd\ ^2P_{3/2}$.

Several transitions sp^4 - nf are observed and some of them are strong due to the mixing of sp^4 with nd.

In accordance with the expectation that the splitting should be large in configurations which contain unpaired s-electrons, the largest hfs intervals are found in the terms ^2D and ^4P of sp^4. In $^4P_{5/2}$ the hfs-interval is about 0.19 cm^{-1}, in $^4P_{3/2}$ 0.13 cm^{-1}, in $^4P_{1/2}$ 0.15 cm^{-1}, in $^2D_{5/2}$ 0.11 cm^{-1} and in $^2D_{3/2}$ 0.07 cm^{-1}.

The computed undisturbed positions of the quartets ^4D and ^4F of (^3P) nd differ a little from the experimental ones, the deviations $E_{obs} - E_{calc}$ being unexpectedly large for 3d ^4F. However, the LS-purity for these quartets (n=3, 4, 5) is on the average more than 90%, and the quartet levels in the diagram (Fig. 7) follow smooth curves. There are interaction possibilities even for the level with the highest J-value ((^3P)nd $^4F_{9/2} \leftrightarrow$ (^1D)nd $^2G_{9/2}$), but the Ritz formula indicates that this effect is very small (see Table XIII). The adopted limits for $^4D_{3/2}$ and nd $^2D_{3/2}$ are somewhat arbitrary and may have to be interchanged.

A relatively large matrix element exists between sp^4 ^2D and (^1D)nd ^2D. There are also important elements sp^4 $^2D \leftrightarrow$ (^1S)nd ^2D. It may seem surprising that the unperturbed position of the term sp^4 ^2D falls above $(^1D)3d$ ^2D. However, from the calculated LS-composition of the levels (Table VII) it is clear that the adopted assignments are the most appropriate ones. The hfs interval above mentioned and the combination properties give further support to these designations. The repulsion effects on sp^4 ^2D from the higher terms (n>3) of (^1D)nd ^2D, and (^1S)nd ^2D exceed the effect from the lower term $(^1D)3d$ ^2D. In the diagonalization it turns out that the term of sp^4 will be pushed downwards and $(^1D)3d$ ^2D upwards.

The expected strong lines of the transition $(^1D)4p$ ^2D - $(^1D)3d$ ^2F, which should fall around 25000 Å, could not be found, which is remarkable since the lines of $(^1D)4p$ ^2F - $(^1D)3d$ ^2G (also at 25000 Å) are quite strong. The "unperturbed" position of $(^1D)3d$ ^2F falls close to that of $(^3P)4d$ ^2F causing a consi-

derable sharing of LS-vectors. Cancellation effects due to the mixed nature of the eigenfunctions of both the upper and lower levels, $(^1D)4p\ ^2D$ being mixed with $(^3P)5p\ ^2D$, may explain the absence of the transition.

All of the terms of $(^1D)4d$ and $(^1S)3d$ are expected to fall above the series limit ^3P and to interact strongly with the continuum. Attempts to find them have not been successful.

5.4 The np configurations

The centroid diagram in Figure 8 shows the structure of the np configurations that build on the parent ^3P. Among the terms which are derived from the parents ^1D and ^1S only those of $(^1D)4p$, namely ^2P, ^2D and ^2F are established. All other terms of these parents are predicted to fall close to or above the first limit and are probably absorbed by the doublet continuum. Although the eigenfunction of $(^1D)np\ ^2F$ may contain contributions from other LS-vectors in the np-configurations causing some interaction with the continuum the transition $(^1D)4s\ ^2D$ - - $(^1D)5p\ ^2F$ ought to be observable.

According to Cowan's Hartree-Fock calculation, the functions $(^1D)4p$ and $(^3P)5p$ are intermingled. The transition array supports the result of this calculation. About fifteen lines of $(^1D)4s$ - $(^3P)5p$ and six transitions $(^3P)4s$ - $(^1D)4p$, some quite strong, are observed. Although the diagram (Fig. 8) does not clearly reveal any distortions, a repulsion integral is likely to shift the terms $5p\ ^2P$ and $5p\ ^2D$ upwards and $(^1D)4p\ ^2P$ and $(^1D)4p\ ^2D$ downwards.

The np configurations are well tied to the other parts of the excited system through combinations ns-n'p, np-n'd and sp^4-np.

5.5 The nf configurations

One of the original aims of this investigation was to find and analyse the configurations 4f and 5f. It has now been possible to obtain not only these configurations but also 6f and 7f, as well as seven levels of 8f and two levels of 9f.

The lower members of the f-series are supported by numerous transitions but the higher members are found mainly through the well pronounced JK-pairs. By means of Cowans' program, matrices are constructed and fitted to the levels of the complete f-configurations. Table XI contains the result of the calculations which show 99-100% purities of the JK notations. This is further supported by Figure 9. The $F^2(3p, nf)$ electrostatic integrals are closely proportional to $(n^*)^{-3}$. The $G^2(3p, nf)$ integrals were also calculated but are small. Possible interactions np $\leftrightarrow$ n'f or nf $\leftrightarrow$ n'f have not been computed, but the fact that the nf-levels strictly obey the JK approximation proves that such effects must be insignificant. The rich flow of transitions to the ns, sp^4 and nd configurations is mainly due not to coupling conditions in nf but to the mixed properties of the levels of nd, ns and sp^4.

The levels of the pair $(^3P_2)nf(1)$ are well resolved for 4f. The registration made with the microwave source reveals the pair structure. For 5f the transitions to $sp^4\ ^4P_{5/2}$ and

the transition to $sp^4\ ^4P_{1/2}$, where the component $(1)_{1/2}$ is dominating, determine the splitting.

5.6 The 6g configuration

The transition array of 4f-6g in Table XII illustrates the appropriateness of the JK-approximation. In spite of the small pair splitting it has been possible to establish twelve levels of 6g even though each individual level is supported only by a single line.

The parameter fit by means of Cowan's program gives $F^2(3p, 6g) = 46\ cm^{-1}$ and a mean deviation of $0.5\ cm^{-1}$. Average purity in the JK approximation is 99.9%.

The transitions 4f-5g are expected around 40000 Å but have not been observed because the sensitivity of the instrument is strongly decreasing in this region.

6. The ionization limit

Martin determined the ionization potential by calculating the series limit of nd $^4F_{9/2}$ from four known members, viz 4d, 5d, 6d and 7d, by means of the Ritz formula. The limit of this series is $3s^2 3p^2\ ^3P_2$, and the lowest limit is then obtained by subtracting the interval $^3P_2 - {}^2P_0$. He supposed this series to be the least perturbed one of those for which at least three members were known. Of the (^3P)nf-series there are now six members known for the highest J-value, and it should be even less perturbed than the nd $^4F_{9/2}$ series. The possible influence of (^1D)nf and (^1S)nf appears to be negligible. By testing

Ritz-formulas with various numbers of parameters one finds that the linear form $\delta = a + bt$ is the most suitable. Here δ is the quantum defect $n - n^*$, $t = (n^*)^{-2} = T/R\zeta^2$ and a and b are adjustable parameters derived from the observations by a least squares calculation. Table XIII shows the result of applying the formula to the series $(^3P_2)nf(5)_{11/2}$ and $(^3P_2)nf(5)_{9/2}$. For comparison the nd $^4F_{9/2}$ and ns $^4P_{5/2}$-series are fitted to a four parameter formula and given in the same Table. The level 3d $^4F_{9/2}$ is likely to be somewhat disturbed by $(^1D)3d\ ^2G_{9/2}$ and the level 9d $^4F_{9/2}$ is established by a weak and diffuse line and thus afflicted with a considerable uncertainty. When disregarding these two members one gets nearly the same value of the limit as from the f-series. Also the ns $^4P_{5/2}$ series appears to be surprisingly undisturbed. In conclusion we adopt for the first ionization limit $3s^23p^2\ ^3P_0$ the value 84580.83 ± 0.12 cm^{-1}, where the estimated uncertainty is composed of ±0.05 cm^{-1} in the connection between the ground configuration and the upper part of the system, ±0.05 cm^{-1} in the limit of the f-series and ±0.10 cm^{-1} in the interval $^3P_2$ - $^3P_0$, giving the root-mean-square error ±0.12 cm^{-1}.

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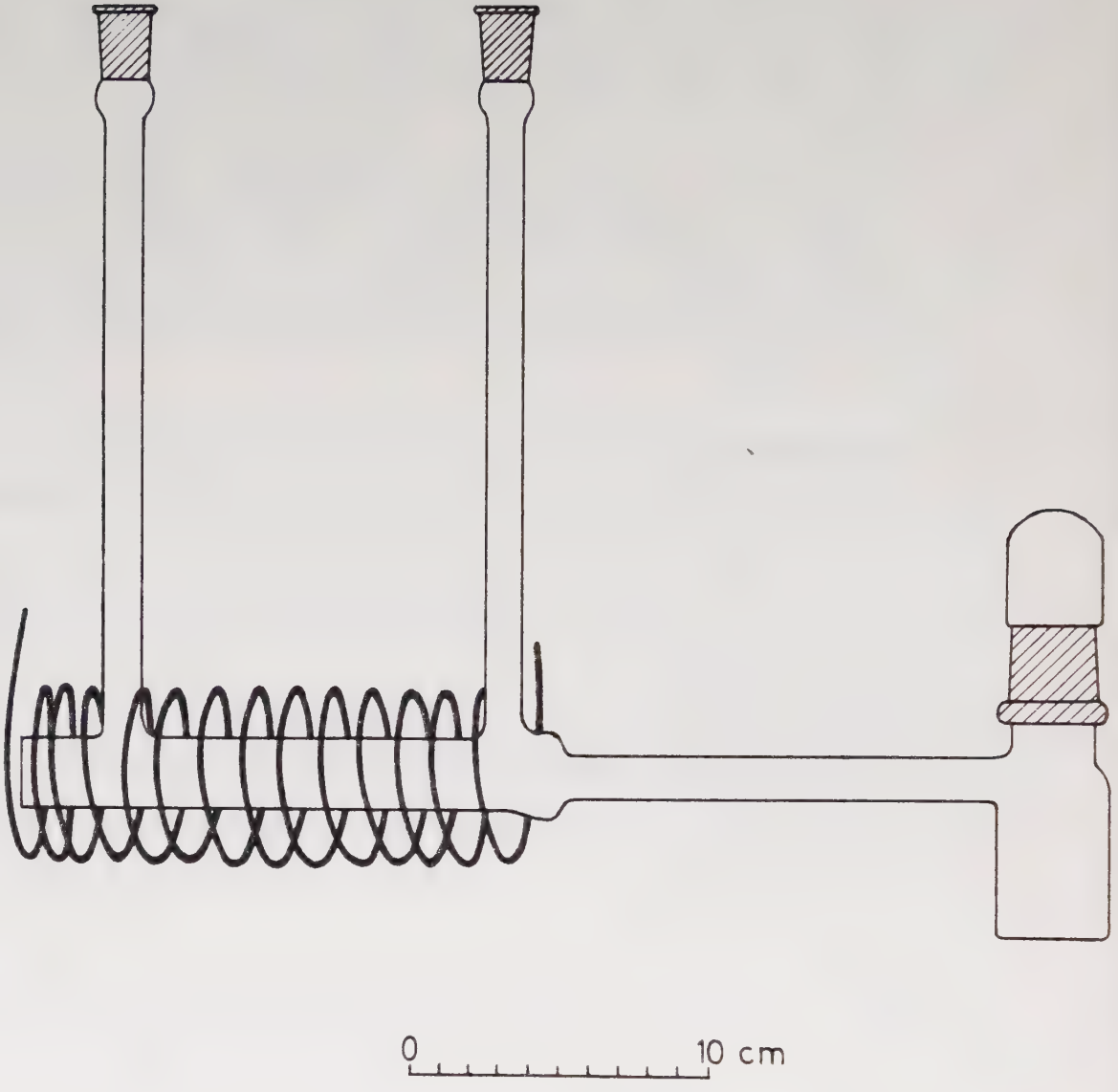

Fig. 1 The high-frequency discharge tube with the surrounding coil. The rear part of the tube (to the right) contains the phosphorus material which is heated.

Fig. 2 Relative intensity of P I and P II lines as a function of vapour pressure. The vapour pressure decreases from I-II.

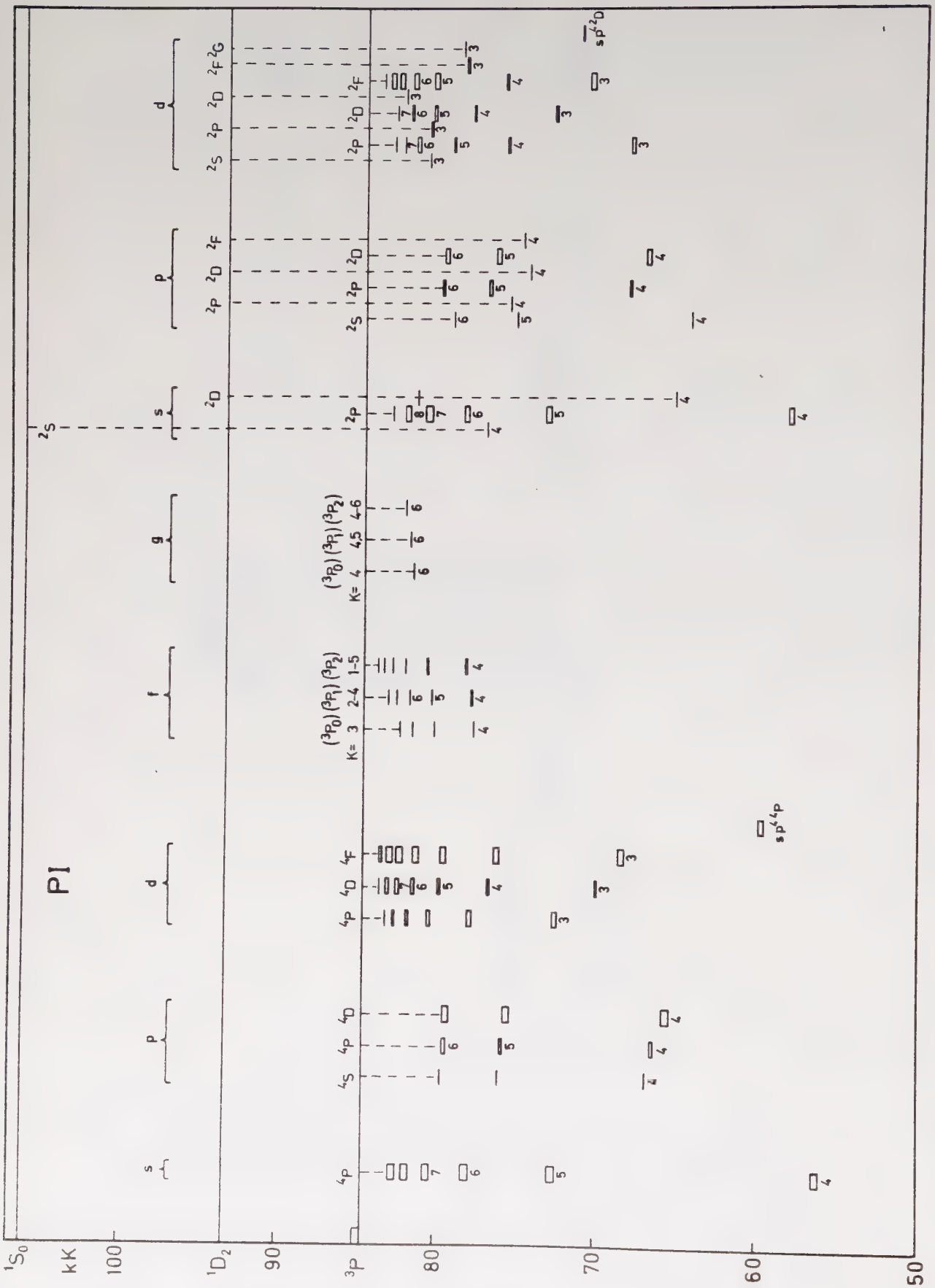

Fig. 3. Upper part of the term system of P I.

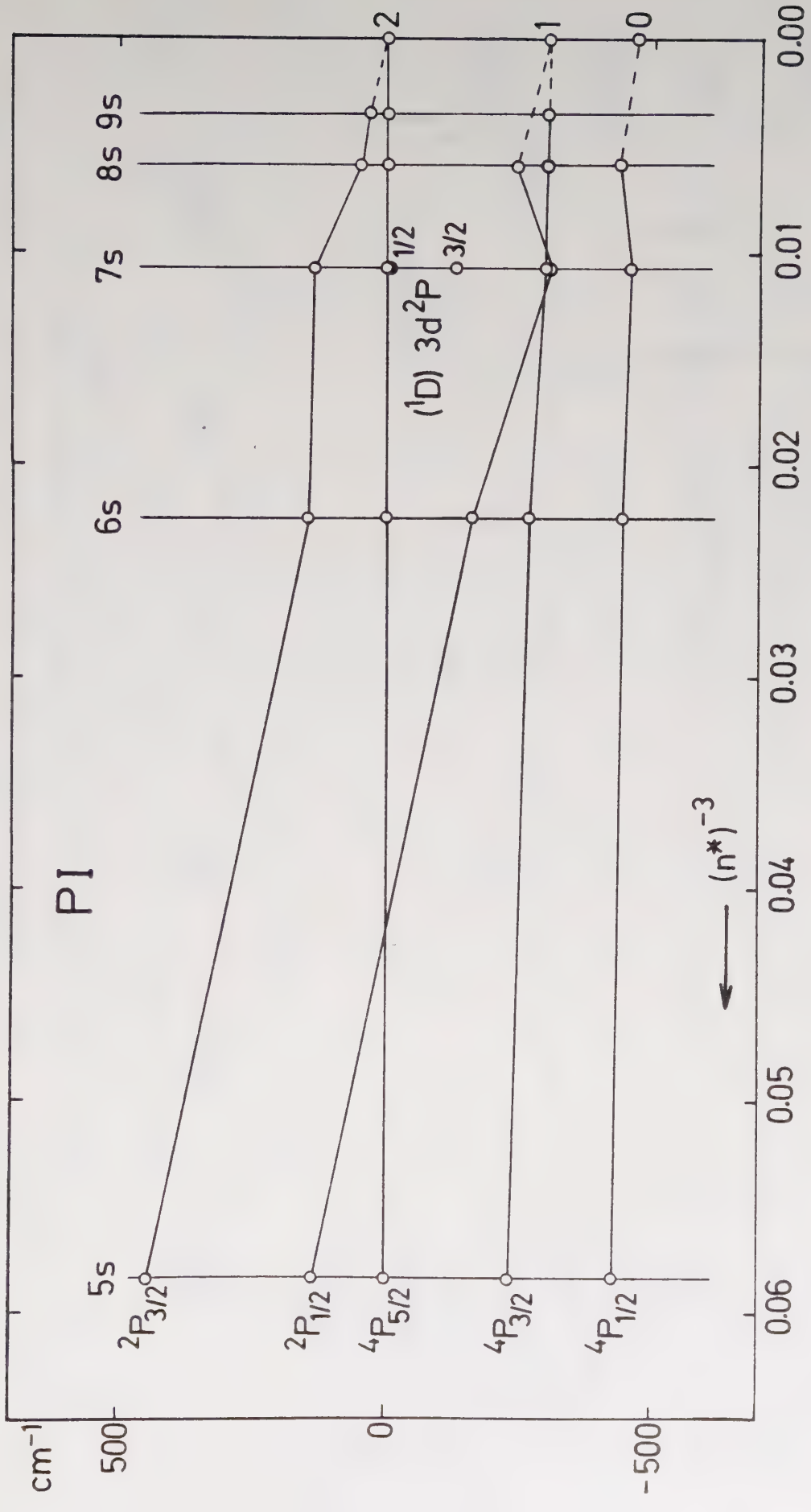

Fig. 4. Convergence diagram for the $(^3P)ns$ levels. The levels are plotted relative to $^4P_{5/2}$ for each n.

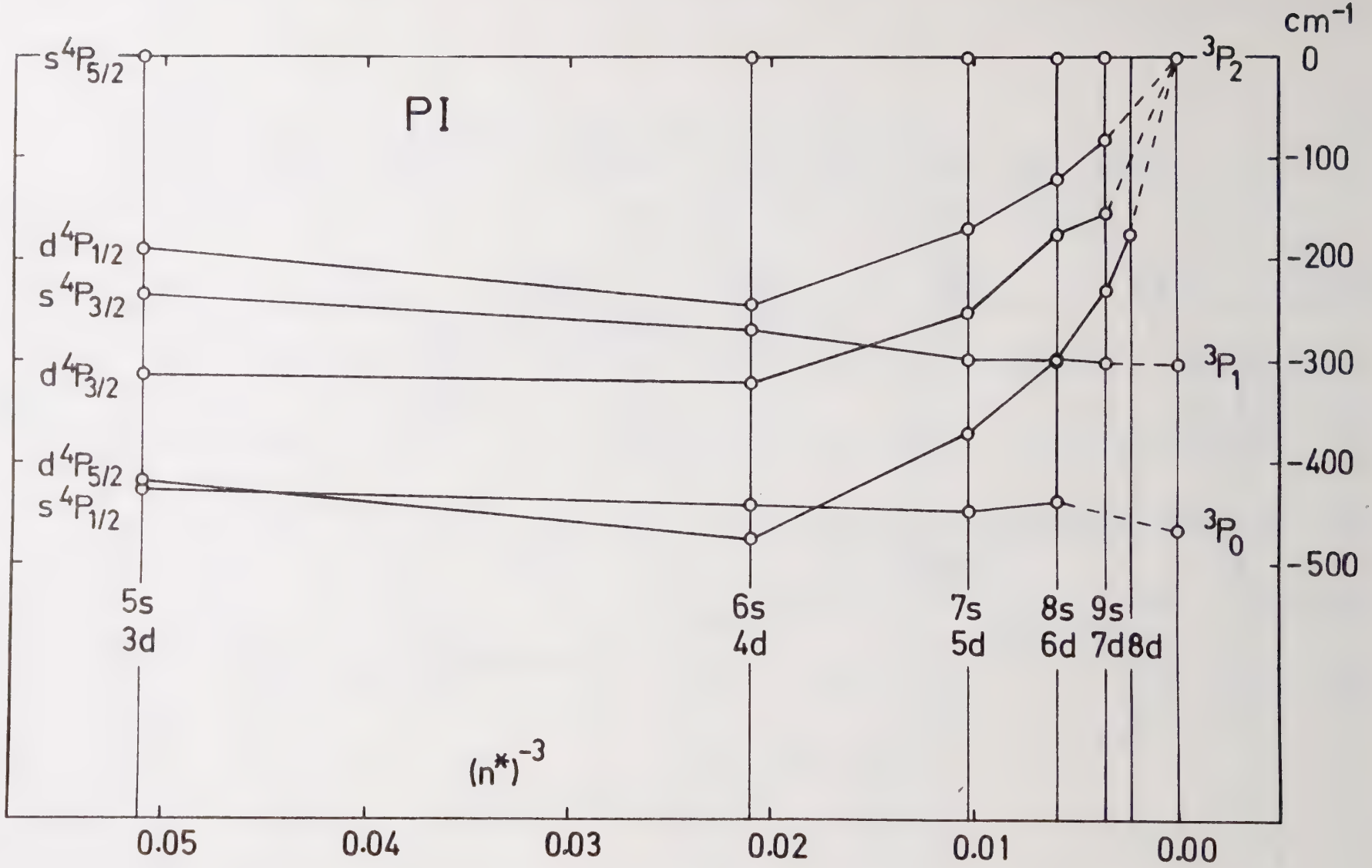

Fig. 5. Comparison between the positions of the levels of $(^3P)nd\ ^4P$ and $(^3P)(n+2)s\ ^4P$. Reference level is $s\ ^4P_{5/2}$ for a given n.

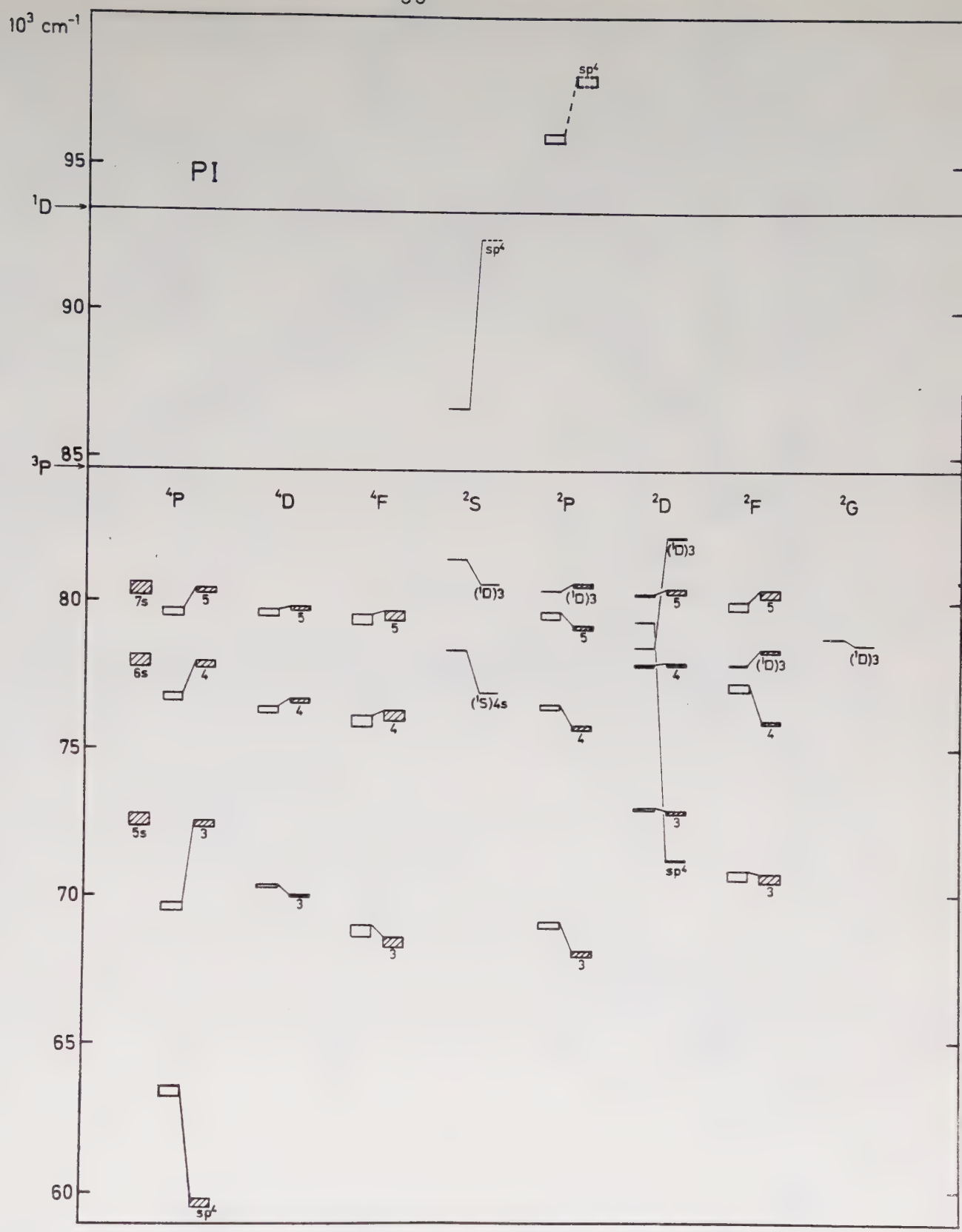

Fig. 6 The calculated unperturbed positions of terms of 3d, 4d, 5d, sp^4 and (^{1}S)4s are compared with the observed positions (cross-hatched). The experimental positions of ^{4}P of 5s, 6s and 7s are also included. The undisturbed position of (^{1}S)4s ^{2}S is not computed from a diagonlization but suggested. Terms marked with dotted lines are not established.

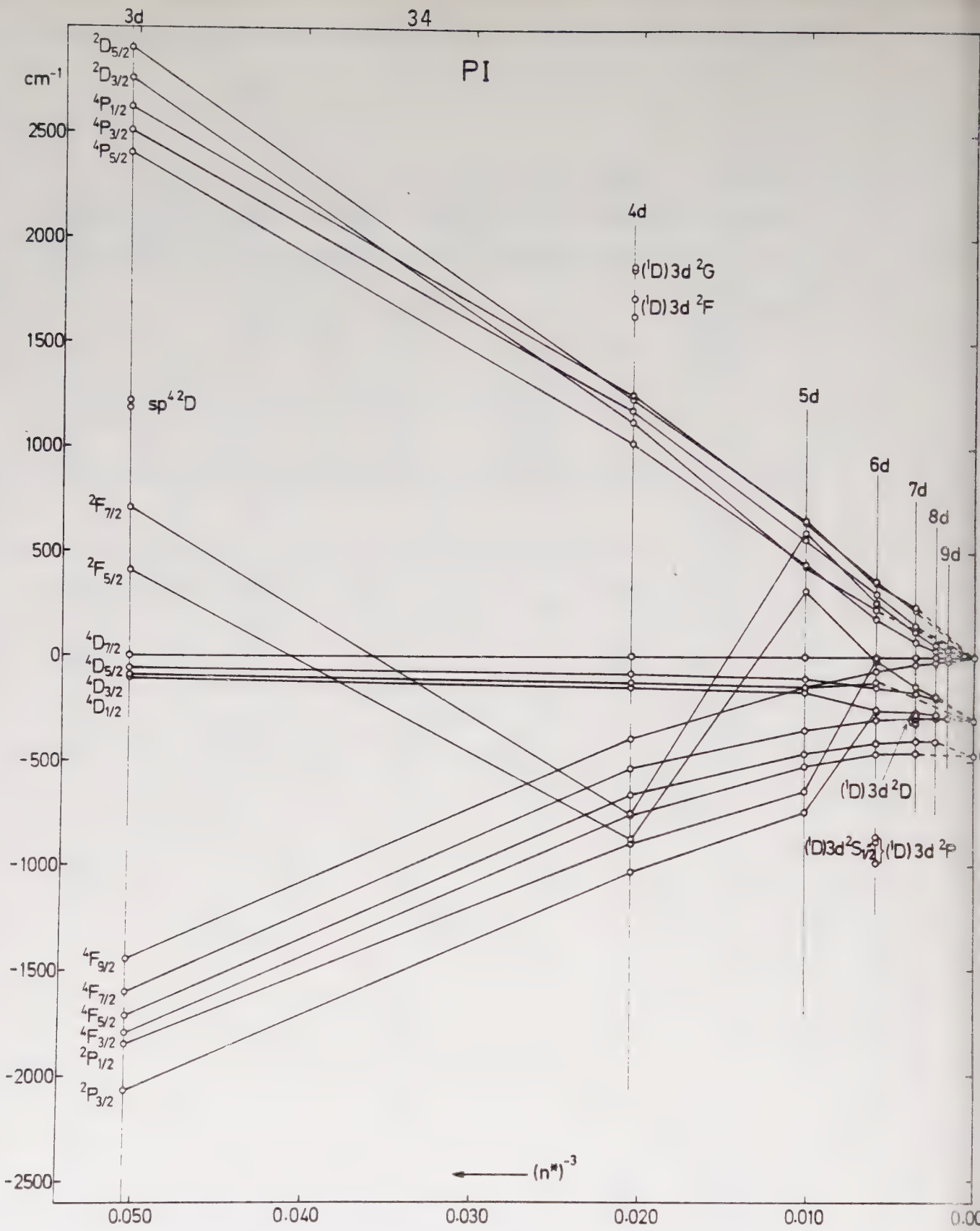

Fig. 7 Centroid diagram of the known levels of $(^3P)nd$, $(^1D)3d$ and sp^4. The positions of the levels are referred to $^4D_{7/2}$ for a given n and the levels of $(^1D)3d$ and sp^4 are placed on the most appropriate n-value.

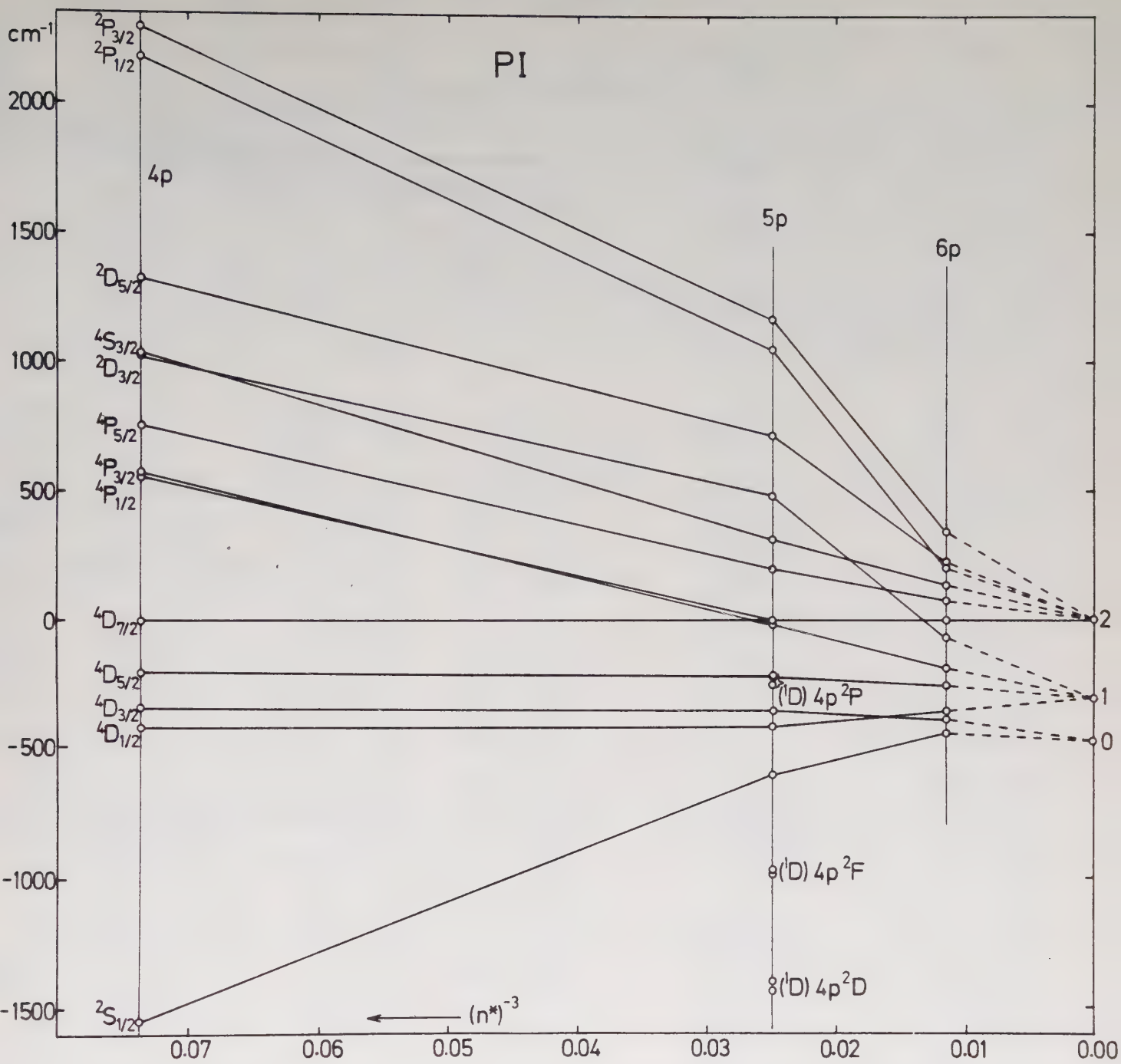

Fig. 8 The structure of $(^3P)4p$, $(^3P)5p$, $(^3P)6p$ and $(^1D)4p$. Reference level is $^4D_{7/2}$ for each n. The levels of $(^1D)4p$ fall close to 5p and are plotted with this configuration.

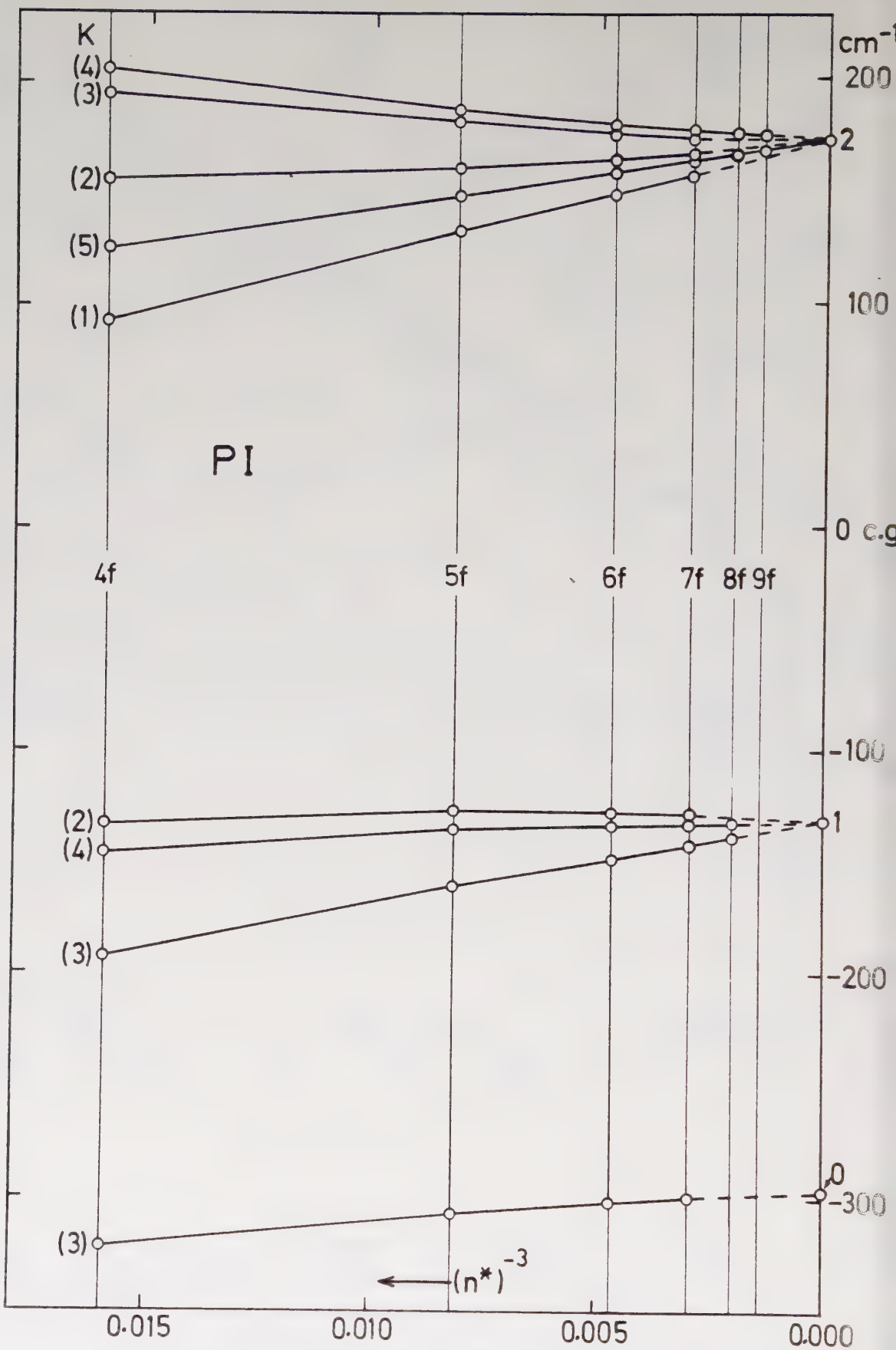

Fig. 9. Relative positions of the levels of the (^{3}P) nf configurations. The figures on the left are the quantum numbers K. The splitting of the pairs is too narrow to be shown.

TABLE I P I lines in the infrared range 4.0 - 1.0 μm.

σ_{corr} The observed σ corrected for a light source effect discussed in the text.

(*) Starred lines were not used in the least squares fit.

( ) Parentheseses indicate that the upper level is determined from this single transitio

H Two hyperfine components compose the line. The centre of gravity is given in the table, further explanation in the text.

u Unsymmetric.

H^1 Three measured hyperfine components have formed the line.

b The transition consists of two hyperfine components. The intensity of one of them is difficult to estimate causing larger uncertainty in the centre of gravity.

Intensity and shape	λ_{air}(Å)	σ(cm^{-1}) Obs.	Corr.	Calc.	Transition
5	37344.841	2677.016	.025	.021	4p 4D5/2 - 3d 4F5/2
146	36417.433	2745.189	.198	.198	4p 4D7/2 - 3d 4F9/2
192	35802.532	2792.337	.346	.342	4p 4D5/2 - 3d 4F7/2
90	35582.272	2809.622	.631	.630	4p 4D1/2 - 3d 4F3/2
146	35551.929	2812.020	.029	.026	4p 4D3/2 - 3d 4F5/2
6	34958.814	2859.729	.708	.706	3d 4P3/2 - 5p 4D3/2
65	34492.280	2898.409	.398	.397	5s 4P5/2 - 5p 4D7/2
24	34330.459	2912.071	.060	.059	5s 4P3/2 - 5p 4D5/2
12	34316.365	2913.267	.256	.257	5s 4P1/2 - 5p 4D1/2
4 u	34278.090	2916.520	.510	.504*	5s 4P3/2 -(1D2)4p 2P3/2
4 H	33976.538	2942.405	.394	.394	5s 2P3/2 - 5p 2D3/2
1	33950.564	2944.656		.651*	5p 2S1/2 - 6s 2P1/2
22	33598.363	2975.524	.513	.512	5s 4P1/2 - 5p 4D3/2
36	33428.151	2990.675	.654	.653	3d 4P3/2 - 5p 4D5/2
6	32674.586	3059.648	.657	.658	4p 4S3/2 - 3d 4D3/2
6 H	32577.779	3068.740	.722	.720	sp42D3/2 -(1D2)4p 2D3/2
3 u	32481.902	3077.798	.788	.798*	5s 2P1/2 - 5p 4S3/2
			.788	.774*	5s 4P1/2 -(1D2)4p 2P1/2
23 H	32457.099	3080.150	.157	.152	4p 2P3/2 - sp42D5/2
6	32355.772	3089.796	.805	.805	4p 4S3/2 - 3d 4D5/2
91 H	32270.901	3097.922	.911	.909	5s 4P5/2 - 5p 4P5/2
5 H	32222.513	3102.574	.554	.558	3d 4P5/2 -(1D2)4p 2P3/2
10 H	32136.160	3110.911	.901	.904	5s 4P1/2 -(1D2)4p 2P3/2
8	32133.443	3111.174	.183	.182	4p 2D3/2 - 3d 4D5/2
32	32074.473	3116.894	.883	.882	5s 4P3/2 - 5p 4P3/2
7	31966.315	3127.440	.429	.431	5s 4P3/2 - 5p 4P1/2
12 H	31906.928	3133.261	.243	.244	sp42D5/2 -(1D2)4p 2D5/2
5	31871.377	3136.756	.735	.735	3d 2D5/2 - 5p 4S3/2
5	31568.788	3166.822	.824	.825	4d 4F9/2 - 6p 4D7/2
92	31483.211	3175.430	.419	.418	5s 2P3/2 - 5p 2D5/2
15	31285.493	3195.498	.477	.477	3d 4P3/2 - 5p 4P3/2
23	31182.573	3206.045	.024	.025	3d 4P3/2 - 5p 4P1/2
83 H	31101.454	3214.407	.396	.397	5s 4P5/2 - 5p 4S3/2
13 H	30932.942	3231.902	.909	.907	4p 2P1/2 - sp42D3/2
51 H	30775.935	3248.406	.395	.396	5s 2P1/2 - 5p 2D3/2
2	30719.185	3254.407		.372*	5p 2S1/2 - 6s 2P3/2
2	30498.832	3277.920	.929	.931	4p 2D5/2 - 3d 2F5/2
11	30267.636	3302.958	.937	.936	3d 4P5/2 - 5p 4P3/2
18	30191.439	3311.294	.283	.282	5s 4P1/2 - 5p 4P3/2
3	30095.589	3321.840	.829	.831	5s 4P1/2 - 5p 4P1/2

9		29842.125	3350.054	.063	.063		4p	4P5/2	-	3d	4D3/2
60		29575.972	3380.201	.210	.210		4p	4P5/2	-	3d	4D5/2
10	H	29370.642	3403.832	.811	.812		3d	4P1/2	-	5p	4S3/2
11	H	29306.120	3411.326	.305	.307		3d	4P3/2	-	5p	4P5/2
311	H	29097.162	3435.824	.833	.834		4p	4P5/2	-	3d	4D7/2
2		28985.777	3449.027		.015*	(3P1)4f	(3)7/2	-		6d	4F7/2
16	H	28984.231	3449.211	.200	.200		5s	4P3/2	-	5p	4S3/2
2		28974.134	3450.413	.392	.392		3d	2D3/2	-	5p	2D3/2
6		28462.108	3512.485	.474	.474		5s	2P3/2	-	5p	2P1/2
16		28419.566	3517.743	.752	.751		4p	4P3/2	-	3d	4D1/2
17	H	28411.134	3518.787	.766	.766		3d	4P5/2	-	5p	4P5/2
2		28338.331	3527.827	.806	.795*		3d	4P3/2	-	5p	4S3/2
98		28288.687	3534.018	.027	.024		4p	4P3/2	-	3d	4D3/2
132	H	28284.165	3534.583	.592	.595		4p	4P1/2	-	3d	4D1/2
2	u	28256.497	3538.044	.046	.056		4d	4F7/2	-	6p	2D5/2
5		28237.852	3540.380	.359	.358		3d	2D5/2	-	5p	2D5/2
127	H	28154.519	3550.859	.868	.868		4p	4P1/2	-	3d	4D3/2
188		28049.419	3564.164	.173	.171		4p	4P3/2	-	3d	4D5/2
118		27959.519	3575.624	.633	.634		4p	2D5/2	-	3d	2F7/2
44		27936.892	3578.520	.529	.529		4p	2D3/2	-	3d	2F5/2
13	H	27678.027	3611.989	.969	.969		3d	2F7/2	-(1D2)4p		2D5/2
2		27595.995	3622.726		.706*	(3P0)4f	(3)5/2	-		6d	2P3/2
24		27575.245	3625.452	.441	.444		5s	2P3/2	-	5p	2P3/2
11		27243.992	3669.533	.542	.545		4p	2S1/2	-	3d	2P3/2
10	H	26181.217	3818.490	.479	.477		5s	2P1/2	-	5p	2P1/2
1		26155.485	3822.247		(.247)	(3P2)4f	(4)7/2	-(3P2)6g		(5)9/2	
1		26144.397	3823.868		(.868)	(3P2)4f	(4)9/2	-(3P2)6g		(5)11/2	
98		26134.439	3825.325	.309	(.310)	(1D2)4p	2F7/2	-(1D2)3d		2G9/2	
2		26123.083	3826.988		(.988)	(3P2)4f	(3)5/2	-(3P2)6g		(4)7/2	
3		26120.162	3827.416		(.416)	(3P2)4f	(3)7/2	-(3P2)6g		(4)9/2	
3		26033.255	3840.193	.177	.178	(1D2)4p	2F7/2	-(1D2)3d		2G7/2	
2		25922.119	3856.657	.652	.653		5p	4P5/2	-	5d	4D5/2
53		25883.898	3862.352	.336	.336	(1D2)4p	2F5/2	-(1D2)3d		2G7/2	
1		25877.781	3863.265		(.265)	(3P1)4f	(4)7/2	-(3P1)6g		(5)9/2	
2		25872.503	3864.053		(.053)	(3P1)4f	(4)9/2	-(3P1)6g		(5)11/2	
2		25817.528	3872.281		(.281)	(3P0)4f	(3)7/2	-(3P0)6g		(4)9/2	
2		25812.716	3873.003		(.003)	(3P0)4f	(3)5/2	-(3P0)6g		(4)7/2	
3		25766.711	3879.918	.898	.898		3d	2F5/2	-(1D2)4p		2D3/2
19		25719.731	3887.005	.014	.017		4p	2S1/2	-	3d	2P1/2
2		25701.707	3889.731		(.731)	(3P2)4f	(5)9/2	-(3P2)6g		(6)11/2	
2		25687.818	3891.834		(.834)	(3P2)4f	(5)11/2	-(3P2)6g		(6)13/2	
2		25618.641	3902.343		(.343)	(3P1)4f	(3)7/2	-(3P1)6g		(4)9/2	
1		25612.806	3903.232		(.232)	(3P1)4f	(3)5/2	-(3P1)6g		(4)7/2	
2		25518.531	3917.652	.647	.646		5p	4D5/2	-	5d	4F5/2
2		25428.931	3931.456	.445	.447		5s	2P1/2	-	5p	2P3/2
2		25388.570	3937.706		.714*		4d	4D7/2	-(3P2)5f		(4)9/2
7		25254.533	3958.605	.600	.598		5p	4P5/2	-	5d	4D7/2
2		25081.770	3985.872	.867	.871		5p	4D3/2	-	5d	4F3/2
4		25053.290	3990.403	.382	.385		3d	2D5/2	-	5p	2P3/2
1		25013.423	3996.763	.758	.763		5p	4P1/2	-	5d	4D1/2
1		24899.788	4015.003		.020*		4d	4D5/2	-(3P2)5f		(3)7/2
20		24899.186	4015.100	.095	.095		5p	4D7/2	-	5d	4F9/2

6		24882.596	4017.777	.772	.770		5p	2S1/2	- 5d 2P3/2
2	H	24877.166	4018.654	.649	.654		5p	4P1/2	- 5d 4D3/2
3	H	24865.787	4020.493	.472	.472		3d	2D3/2	- 5p 2P1/2
1		24812.003	4029.208	.203	.203		5p	4P3/2	- 5d 4D3/2
15		24801.583	4030.901	.896	.894		5p	4D5/2	- 5d 4F7/2
6		24696.026	4048.130	.125	.126		5p	4D1/2	- 5d 4F3/2
10		24693.171	4048.598	.593	.593		5p	4D3/2	- 5d 4F5/2
2	H	24682.794	4050.300	.280	.282		3d	2F7/2	-(1D2)4p 2F7/2
8	H	24658.138	4054.350	.357	.358		4p	2D5/2	- sp42D5/2
2		24548.292	4072.492	.487	.483		5p	4P3/2	- 5d 4D5/2
3	H	24293.846	4115.146	.141	.138		5p	2S1/2	- 5d 2P1/2
1		24186.167	4133.467	.446	.442		3d	2D3/2	- 5p 2P3/2
43	H	24165.582	4136.988	.997	.998		4p	4D7/2	- 3d 4D5/2
2		24042.827	4158.110	.105	.109		5p	4D7/2	- 5d 4D7/2
287		23844.973	4192.612	.621	.622		4p	4D7/2	- 3d 4D7/2
1		23775.788	4204.812		.834*	(3P2)4f	(3)7/2	-	7d 2F5/2
					.839*		4d	4F3/2	-(3P0)5f (3)5/2
3		23295.844	4291.440		.453*		4d	4F9/2	-(3P2)5f (5)11/2
4		23258.881	4298.260	.269	.271		4p	2P3/2	- 3d 4P5/2
52		23200.005	4309.168	.177	.177		4p	4D5/2	- 3d 4D3/2
2	H	23110.585	4325.841	.821	.827		3d	2F5/2	-(1D2)4p 2F5/2
3	H	23069.373	4333.569	.576	.580		4p	4S3/2	- sp42D5/2
124		23038.830	4339.314	.323	.323		4p	4D5/2	- 3d 4D5/2
2	H	22956.080	4354.956	.963	.957		4p	2D3/2	- sp42D5/2
1	H	22885.850	4368.320	.327	.331		4p	4S3/2	- sp42D3/2
5	H	22774.396	4389.698	.705	.708		4p	2D3/2	- sp42D3/2
59		22747.247	4394.937	.946	.947		4p	4D5/2	- 3d 4D7/2
34		22577.928	4427.896	.905	.908		4p	4D3/2	- 3d 4D1/2
1	u	22527.489	4437.810		.807*		4d	4F7/2	-(3P2)5f (5)9/2
53		22495.240	4444.172	.181	.182		4p	4D3/2	- 3d 4D3/2
79		22343.677	4474.318	.327	.328		4p	4D3/2	- 3d 4D5/2
3	H	22293.807	4484.327	.326	.324		4p	2P3/2	- 5s 4P3/2
41	H	22194.143	4504.464	.473	.478		4p	4D1/2	- 3d 4D1/2
49		22114.218	4520.744	.753	.751		4p	4D1/2	- 3d 4D3/2
2	H	22104.536	4522.724	.733	.733		4p	2P1/2	- 3d 4P3/2
2	H	21726.922	4601.329	.328	.328		4p	2P1/2	- 5s 4P3/2
1	H	21620.481	4623.982	.989	.985		4p	4P5/2	- sp42D5/2
10		21482.309	4653.723	.732	.731		4p	2P3/2	- 3d 2D3/2
1	u	21463.929	4657.708		.698*		5p	4S3/2	- 7s 4P5/2
9	H	21184.560	4719.131	.130	.127		4p	2P3/2	- 5s 4P5/2
53		20955.455	4770.725	.734	.735		4p	2P1/2	- 3d 2D3/2
1		20940.241	4774.191		.187*		5p	4P5/2	- 7s 4P5/2
125		20841.621	4796.782	.791	.789		4p	2P3/2	- 3d 2D5/2
1		20746.194	4818.846	.841	.863*		5p	4P3/2	- 5d 4P1/2
11	H	20588.606	4855.730	.729	.727		4p	2P3/2	- 5s 2P1/2
2	u	20419.163	4896.024		.035*		5p	4D5/2	- 7s 4P3/2
5	H	20406.775	4898.996	.978	.975		3d	2D5/2	-(3P1)4f (3)5/2
4		20394.107	4902.039	.048	.049		4p	4D7/2	- 3d 2F7/2
18		20349.581	4912.765	.747	.752		3d	2D3/2	-(3P0)4f (3)5/2
28	H	20211.831	4946.247	.229	.228		3d	2D5/2	-(3P1)4f (4)7/2
25	H	20104.182	4972.732	.731	.730		4p	2P1/2	- 5s 2P1/2
2		20100.261	4973.702		.698*		5p	4D7/2	- 7s 4P5/2

7	H	19827.786	5042.051	.033	.032	3d	2D3/2	-(3P1)4f (3)5/2
1		19757.894	5059.887	.871	.868	(1D2)4p	2P3/2	-(1D2)3d 2P3/2
1		19671.276	5082.167	.159	.159	5s	4P3/2	-(3P0)4f (3)5/2
1		19596.651	5101.520	.502	.509	3d	2D3/2	-(3P1)4f (2)3/2
22	H	19594.062	5102.194	.176	.174	3d	2D3/2	-(3P1)4f (2)5/2
6		19371.661	5160.771	.753	.754	3d	4P3/2	-(3P0)4f (3)5/2
64	H	19368.054	5161.732	.731	.729	4p	2P3/2	- 5s 2P3/2
2	H	19350.858	5166.319	.303	.301	(1D2)4p	2P3/2	-(1D2)3d 2S1/2
1		19285.156	5183.920	.904	.903	(1D2)4p	2P3/2	-(1D2)3d 2P1/2
1	H	19283.891	5184.260	.242	.245	3d	2D5/2	-(3P2)4f (1)3/2
2	H	19227.569	5199.446	.430	.431	(1D2)4p	2P1/2	-(1D2)3d 2S1/2
4		19183.291	5211.447	.439	.439	5s	4P3/2	-(3P1)4f (3)5/2
10	H	19131.526	5225.548	.530	.527	3d	4P1/2	-(3P1)4f (2)3/2
13	H	19047.383	5248.632	.614	.612	3d	2D5/2	-(3P2)4f (2)5/2
4		18976.526	5268.230	.212	.213	3d	4P5/2	-(3P0)4f (3)5/2
61		18973.803	5268.986	.968	.969	3d	4P5/2	-(3P0)4f (3)7/2
7		18966.834	5270.922	.914	.916	5s	4P3/2	-(3P1)4f (2)3/2
42	H	18964.431	5271.590	.582	.581	5s	4P3/2	-(3P1)4f (2)5/2
15	H	18938.765	5278.734	.733	.733	4p	2P1/2	- 5s 2P3/2
1		18925.278	5282.496		.515*	4d	4D7/2	-(3P2)6f (4)9/2
25		18915.875	5285.122	.104	.104	3d	2D5/2	-(3P2)4f (3)7/2
7		18914.754	5285.435	.417	.420	3d	2D5/2	-(3P2)4f (3)5/2
6		18898.250	5290.051	.033	.034	3d	4P3/2	-(3P1)4f (3)5/2
92		18881.157	5294.840	.822	.821	3d	2D5/2	-(3P2)4f (4)7/2
2		18787.465	5321.245		.229*	(1D2)4p	2P3/2	- 7s 2P3/2
6	H	18766.055	5327.316	.298	.303	3d	2D3/2	-(3P2)4f (1)3/2
8		18688.135	5349.528	.510	.511	3d	4P3/2	-(3P1)4f (2)3/2
24		18685.820	5350.191	.173	.176	3d	4P3/2	-(3P1)4f (2)5/2
5	H	18608.256	5372.492	.484	.483	5s	4P5/2	-(3P2)4f (4)7/2
1		18544.780	5390.881	.863	.865	3d	2D3/2	-(3P2)4f (2)3/2
46		18542.004	5391.688	.670	.670	3d	2D3/2	-(3P2)4f (2)5/2
1		18523.861	5396.969	.948	.950	3d	4D3/2	- 5p 4D1/2
7		18522.004	5397.510	.492	.493	3d	4P5/2	-(3P1)4f (3)5/2
106		18518.903	5398.414	.396	.396	3d	4P5/2	-(3P1)4f (3)7/2
27		18416.283	5428.495	.477	.478	3d	2D3/2	-(3P2)4f (3)5/2
7		18414.302	5429.079	.058	.059	3d	4D5/2	- 5p 4D3/2
27	H[1]	18339.029	5451.363	.345	.321*	3d	4P1/2	-(3P2)4f (1)3/2
54	H	18338.548	5451.506	.488	.486	3d	4P1/2	-(3P2)4f (1)1/2
2		18320.121	5456.989	.971	.970	3d	4P5/2	-(3P1)4f (2)3/2
28	H	18317.893	5457.653	.635	.635	3d	4P5/2	-(3P1)4f (2)5/2
3	H	18314.919	5458.539	.538	.530	4p	2D5/2	- 5s 4P3/2
1		18258.187	5475.500	.479	.479	3d	4D1/2	- 5p 4D3/2
2		18207.012	5490.890		.875*	4d	4F7/2	-(3P1)6f (3)7/2
12		18162.308	5504.405	.384	.382	3d	4D7/2	- 5p 4D5/2
15	H	18127.739	5514.902	.884	.884	3d	4P1/2	-(3P2)4f (2)3/2
186		18007.629	5551.686	.695	.698	4p	4S3/2	- 3d 4P5/2
6	H	17982.917	5559.315	.296	.300	sp4	2D3/2	- 5p 2P1/2
4		17980.611	5560.028	.007	.006	3d	4D5/2	- 5p 4D5/2
3		17979.799	5560.279	.271	.272	5s	4P3/2	-(3P2)4f (2)3/2
14		17977.193	5561.085	.077	.077	5s	4P3/2	-(3P2)4f (2)5/2
116		17938.546	5573.060	.075	.075	4p	2D3/2	- 3d 4P5/2

17	H[1]	17931.261	5575.330	.312	.305		3d	4P3/2	-(3P2)4f (1)3/2
6	H	17930.750	5575.489	.471	.470		3d	4P3/2	-(3P2)4f (1)1/2
3		17883.644	5590.175	.154	.152		3d	4D3/2	- 5p 4D5/2
5		17858.990	5597.892	.884	.885		5s	4P3/2	-(3P2)4f (3)5/2
6	H	17763.678	5627.928	.937	.938		4p	2D5/2	- 3d 2D3/2
2	u	17759.676	5629.196		.207*		5p	4P5/2	- 6d 4D7/2
4	H	17757.887	5629.763	.756	.754		sp44	P1/2	- 4p 4D3/2
8		17729.167	5638.883	.865	.867		3d	4P3/2	-(3P2)4f (2)3/2
16		17726.633	5639.689	.671	.672		3d	4P3/2	-(3P2)4f (2)5/2
3		17685.806	5652.708		.725*		4d	4F9/2	-(3P2)6f (5)11/2
3	H	17670.373	5657.645	.638	.635		sp44	P3/2	- 4p 4D1/2
95	H	17665.680	5659.148	.157	.157		4p	4S3/2	- 3d 4P3/2
4		17611.692	5676.496	.478	.479		3d	4P3/2	-(3P2)4f (3)5/2
46	H	17599.197	5680.526	.535	.534		4p	2D3/2	- 3d 4P3/2
3	H	17592.217	5682.780	.762	.764		3d	4P5/2	-(3P2)4f (1)3/2
1		17565.952	5691.277	.269	.275		5s	4P1/2	-(3P2)4f (1)1/2
18		17559.605	5693.334	.333	.333		4p	2D5/2	- 5s 4P5/2
8	H	17517.446	5707.036	.017	.021		sp42	D5/2	- 5p 2P3/2
1		17473.513	5721.385	.379	.381	(1D2)	4p	2F7/2	- 5d 2F7/2
20	H	17460.823	5725.543	.522	.523		3d	4D7/2	- 5p 4D7/2
1		17458.037	5726.457		.470*		5p	4P3/2	- 6d 4D3/2
11	H	17434.436	5734.209	.202	.204		sp44	P3/2	- 4p 4D3/2
48		17429.779	5735.741	.720	.720		3d	2F7/2	- 5p 2D5/2
299	H	17423.667	5737.753	.752	.752		4p	4S3/2	- 5s 4P3/2
2		17397.624	5746.342	.324	.326		3d	4P5/2	-(3P2)4f (2)3/2
14		17395.181	5747.149	.131	.131		3d	4P5/2	-(3P2)4f (2)5/2
4		17388.700	5749.291		.299*		5p	4D5/2	- 6d 4F7/2
145		17359.005	5759.126	.125	.129		4p	2D3/2	- 5s 4P3/2
5		17349.892	5762.151		.119*		5p	4D7/2	- 6d 4F9/2
12		17341.769	5764.850	.829	.829		3d	4D5/2	- 5p 4P3/2
3		17325.867	5770.141		.124*		5p	4D3/2	- 6d 4F5/2
74		17323.333	5770.985	.994	.995		4p	2D5/2	- 3d 2D5/2
2		17300.166	5778.713		.685*		5p	4D1/2	- 6d 4F3/2
4	H	17292.826	5781.166	.145	.147		3d	4D5/2	- 5p 4D7/2
289	H	17286.914	5783.132	.141	.141		4p	4S3/2	- 3d 4P1/2
29		17285.428	5783.640	.622	.623		3d	4P5/2	-(3P2)4f (3)7/2
4		17284.487	5783.955	.937	.938		3d	4P5/2	-(3P2)4f (3)5/2
1		17271.295	5788.373		.361*	(1D2)	4p	2P3/2	- 6d 2P3/2
1		17256.436	5793.357	.339	.340		3d	4P5/2	-(3P2)4f (4)7/2
11		17251.556	5794.996	.975	.976		3d	4D3/2	- 5p 4P3/2
33		17235.427	5800.419	.398	.398		3d	2F5/2	- 5p 2D3/2
104	H	17223.279	5804.510	.519	.518		4p	2D3/2	- 3d 4P1/2
11	H	17220.208	5805.545	.524	.524		3d	4D3/2	- 5p 4P1/2
8	H	17213.520	5807.801	.797	.795	(1D2)	4p	2P3/2	-(1D2)5s 2D5/2
2		17213.413	5807.837	.822	.824		5p	2D5/2	-(1D2)3d 2D5/2
2		17203.244	5811.270	.249	.249		3d	4D1/2	- 5p 4P3/2
2		17195.426	5813.912	.908	.908	(1D2)	4p	2P3/2	-(1D2)5s 2D3/2
2		17172.983	5821.510		.491*	(1D2)	4p	2P1/2	- 6d 2P3/2
9		17172.084	5821.815	.794	.798		3d	4D1/2	- 5p 4P1/2
1		17151.765	5828.712		.719*		5p	4D7/2	- 6d 4D7/2
471		17112.479	5842.093	.102	.104		4p	4P5/2	- 3d 4P5/2
2		17097.989	5847.044	.040	.038	(1D2)	4p	2P1/2	-(1D2)5s 2D3/2

13	H	17033.398	5869.216	.209	.209		sp44P3/2	-	4p 4D5/2
24		16924.020	5907.148	.157	.159		4p 4S3/2	-	3d 2D3/2
4	H	16899.906	5915.577	.570	.577		sp44P5/2	-	4p 4D3/2
43	H	16872.863	5925.058	.037	.035		3d 4D7/2	-	5p 4P5/2
16		16862.993	5928.526	.535	.536		4p 2D3/2	-	3d 2D3/2
419	H	16803.393	5949.554	.563	.563		4p 4P5/2	-	3d 4P3/2
221	H	16738.678	5972.556	.555	.555		4p 4S3/2	-	5s 4P5/2
11		16715.938	5980.681	.660	.659		3d 4D5/2	-	5p 4P5/2
73	H	16678.981	5993.933	.932	.932		4p 2D3/2	-	5s 4P5/2
2		16632.100	6010.828	.807	.806		3d 4D3/2	-	5p 4P5/2
225		16613.054	6017.719	.718	.718		4p 4P3/2	-	5s 4P1/2
588		16590.073	6026.055	.064	.064		4p 4P3/2	-	3d 4P5/2
4		16585.270	6027.800		.826*	(1D2)	4p 2P3/2	-	6d 2P1/2
3		16569.772	6033.438	.417	.423		3d 2F5/2	-	5p 2D5/2
35		16566.683	6034.563	.562	.562		4p 4P1/2	-	5s 4P1/2
4	b	16523.868	6050.199	.208	.217*		4p 4S3/2	-	3d 2D5/2
20	H	16522.803	6050.589	.582	.581		sp44P5/2	-	4p 4D5/2
1627	H	16482.918	6065.230	.226	.225		4s 2P3/2	-	4p 2S1/2
22		16465.666	6071.585	.594	.594		4p 2D3/2	-	3d 2D5/2
4		16396.578	6097.168	.147	.147		3d 4D5/2	-	5p 4S3/2
42	H	16364.403	6109.156	.155	.154		4p 4S3/2	-	5s 2P1/2
2		16315.900	6127.317	.296	.294		3d 4D3/2	-	5p 4S3/2
66		16307.354	6130.528	.527	.531		4p 2D3/2	-	5s 2P1/2
66		16299.412	6133.515	.524	.523		4p 4P3/2	-	3d 4P3/2
203	H	16292.970	6135.940	.939	.936		4p 2D5/2	-	5s 2P3/2
296		16254.773	6150.359	.368	.367		4p 4P1/2	-	3d 4P3/2
2		16220.948	6163.184		.219*		5p 4D3/2	-	6d 2P1/2
79		16093.173	6212.118	.117	.118		4p 4P3/2	-	5s 4P3/2
41	H	15988.196	6252.906	.899	.906		sp44P5/2	-	4p 4D7/2
15		15976.453	6257.502	.511	.507		4p 4P3/2	-	3d 4P1/2
228	H	15962.528	6262.961	.960	.960		4p 4P5/2	-	5s 4P5/2
23	H	15933.581	6274.339	.348	.351		4p 4P1/2	-	3d 4P1/2
1		15767.041	6340.612	.621	.622		4p 4P5/2	-	3d 2D5/2
714		15711.518	6363.019	.015	.017		4s 2P1/2	-	4p 2S1/2
1	H	15665.972	6381.518	.527	.525		4p 4P3/2	-	3d 2D3/2
4		15583.815	6415.161	.160	.157		4p 4S3/2	-	5s 2P3/2
7		15532.070	6436.533	.532	.534		4p 2D3/2	-	5s 2P3/2
15	H	15507.043	6446.921	.920	.921		4p 4P3/2	-	5s 4P5/2
2		15471.744	6461.630	.617	.603		5s 2P3/2	-	6p 2D5/2
1		15447.932	6471.590	.577	.576		5s 2P1/2	-	6p 2D3/2
3	H	15410.998	6487.100	.084	.087		sp42D5/2	-(3P0)	4f (3)7/2
6	H	15326.005	6523.075	.068	.067		sp44P1/2	-	4p 4P1/2
5	H	15286.544	6539.914	.907	.911		sp44P1/2	-	4p 4P3/2
17		15246.903	6556.917	.913	.913	(1D2)	4p 2F7/2	-(1D2)	5s 2D5/2
2	H	15240.539	6559.655		.638*	(1D2)	4p 2F5/2	-	6d 2P3/2
1		15195.562	6579.071	.067	.071	(1D2)	4p 2F5/2	-(1D2)	5s 2D5/2
1		15192.320	6580.475	.462	.470		5s 2P3/2	-	6p 2P3/2
1	H	15191.389	6580.878	.862	.860		sp42D3/2	-(3P1)	4f (3)5/2
6	H	15181.447	6585.188	.184	.185	(1D2)	4p 2F5/2	-(1D2)	5s 2D3/2
10	H	15149.942	6598.882	.891	.892		4p 4D7/2	-	3d 4P5/2
3	b	15111.511	6615.664	.648	.611*		sp42D5/2	-(3P1)	4f (3)5/2
24	H	15084.469	6627.524	.517	.518		sp44P3/2	-	4p 4P1/2

8	b	15053.889	6640.987	.971	.002*	sp42D3/2	-(3P1)4f (2)5/2
1	c	15046.346	6644.316	.309	.361*	sp44P3/2	- 4p 4P3/2
7	H	15004.506	6662.882	.866	.864	sp42D5/2	-(3P1)4f (4)7/2
2	u	14971.266	6677.637	.624	.622*	5s 2P1/2	- 6p 4S3/2
				.624	.632*	5s 4P5/2	- 6p 4D7/2
2		14823.592	6744.160	.144	.144	(1D2)4p 2P3/2	-(1D2)3d 2D5/2
1		14800.251	6754.796	.783	.784	5s 4P5/2	- 6p 4P5/2
14		14699.251	6801.209	.218	.217	4p 4D5/2	- 3d 4P5/2
98	H	14646.423	6825.740	.733	.733	sp44P5/2	- 4p 4P3/2
33	H	14640.870	6828.329	.322	.322	sp44P3/2	- 4p 4P5/2
2	u	14560.234	6866.145	.129	.131*	sp42D3/2	-(3P2)4f (1)3/2
135		14470.615	6908.668	.677	.676	4p 4D5/2	- 3d 4P3/2
1		14465.941	6910.900	.877	.881	3d 4P5/2	- 6p 4P3/2
1		14444.284	6921.262	.241	.237	3d 4F3/2	- 5p 2S1/2
173		14430.496	6927.875	.874	.875	4p 4D3/2	- 5s 4P1/2
10	H	14425.001	6930.514	.498	.498	sp42D3/2	-(3P2)4f (2)5/2
5		14413.151	6936.212	.221	.222	4p 4D3/2	- 3d 4P5/2
13	H	14348.799	6967.320	.304	.306	sp42D3/2	-(3P2)4f (3)5/2
2		14327.172	6977.837	.816	.815	3d 2P1/2	- 5p 2S1/2
256		14307.826	6987.272	.271	.271	4p 4D5/2	- 5s 4P3/2
28	H	14296.294	6992.908	.901	.900	sp44P1/2	- 4p 2D3/2
10		14291.547	6995.231	.227	.227	(1D2)4p 2D5/2	-(1D2)5s 2D5/2
4	H	14278.222	7001.759	.743	.741	sp42D5/2	-(3P2)4f (3)7/2
4	H	14277.580	7002.074	.058	.057	sp42D5/2	-(3P2)4f (3)5/2
150		14272.747	7004.445	.444	.444	4p 4D1/2	- 5s 4P1/2
65	H	14262.045	7009.701	.694	.694	sp44P5/2	- 4p 4P5/2
31	H	14258.435	7011.476	.460	.458	sp42D5/2	-(3P2)4f (4)7/2
68	H	14252.723	7014.286	.279	.277	sp44P1/2	- 4p 4S3/2
479		14241.635	7019.747	.746	.748	4p 4D7/2	- 5s 4P5/2
1		14230.975	7025.005	.001	.000	(1D2)4p 2D3/2	-(1D2)5s 2D5/2
3		14218.609	7031.115	.111	.113	(1D2)4p 2D3/2	-(1D2)5s 2D3/2
40		14193.262	7043.671	.680	.681	4p 4D3/2	- 3d 4P3/2
18		14097.774	7091.380	.359	.360	3d 4F5/2	- 5p 4D3/2
33	H	14085.903	7097.356	.349	.351	sp44P3/2	- 4p 2D3/2
21		14066.777	7107.006	.985	.987	3d 4F7/2	- 5p 4D5/2
10		14064.630	7108.091	.070	.071	3d 4F3/2	- 5p 4D1/2
67	H	14043.610	7118.730	.723	.728	sp44P3/2	- 4p 4S3/2
3		14040.630	7120.241	.250	.250	4p 4D1/2	- 3d 4P3/2
85		14036.622	7122.274	.273	.275	4p 4D3/2	- 5s 4P3/2
22	H	14000.167	7140.820	.802	.801	3d 2F7/2	-(3P1)4f (4)9/2
1		13953.548	7164.677	.656	.649	3d 2P1/2	- 5p 4D1/2
5		13947.751	7167.655	.664	.664	4p 4D3/2	- 3d 4P1/2
2		13942.511	7170.349	.328	.326	3d 4F3/2	- 5p 4D3/2
22		13937.424	7172.966	.945	.947	3d 4F9/2	- 5p 4D7/2
3		13894.151	7195.306	.285	.287	3d 2P3/2	- 5p 2S1/2
7		13887.321	7198.845	.844	.845	4p 4D1/2	- 5s 4P3/2
47	H	13842.653	7222.074	.073	.073	4p 4D5/2	- 5s 4P5/2
4		13842.167	7222.328	.307	.308	3d 4F5/2	- 5p 4D5/2
9	H	13800.332	7244.222	.231	.233	4p 4D1/2	- 3d 4P1/2
35	H	13763.640	7263.534	.516	.515	3d 2F5/2	-(3P0)4f (3)7/2
31	H	13734.913	7278.726	.719	.723	sp44P5/2	- 4p 2D3/2

c) One of the hfs components is masked by a PH molecular line.

41	H	13694.692	7300.103	.096	.100		sp44P5/2	-	4p 4S3/2
1		13642.279	7328.150	.129	.129		3d 4F7/2	-	5p 4D7/2
2		13588.630	7357.082	.081	.078		4p 4D3/2	-	5s 4P5/2
36	H	13522.681	7392.962	.944	.942		3d 2F5/2	-(3P1)4f	(3)7/2
86		13485.193	7413.514	.496	.493		3d 2F7/2	-(3P2)4f	(5)9/2
76	H	13438.428	7439.312	.294	.292		3d 2F5/2	-(3P1)4f	(4)7/2
1		13415.207	7452.189	.171	.181		3d 2F5/2	-(3P1)4f	(2)5/2
3		13364.463	7480.485	.467	.466		3d 2F7/2	-(3P2)4f	(3)7/2
13		13350.035	7488.569	.551	.550		3d 2F7/2	-(3P2)4f	(4)9/2
6		13347.125	7490.202	.184	.183		3d 2F7/2	-(3P2)4f	(4)7/2
1		13340.943	7493.673	.672	.678		4p 4D3/2	-	5s 2P1/2
1	u	13280.748	7527.638		.648*		5s 4P5/2	-(3P1)5f	(2)5/2
1	H	13190.166	7579.333	.326	.321		sp44P5/2	-	4p 2D5/2
1		13175.050	7588.029	.013	.013		4p 2P3/2	-	4d 2P3/2
1		13166.370	7593.031		.044*		3d 2D3/2	-(3P1)5f	(2)5/2
5		12974.991	7705.027	.011	.017		4p 2P1/2	-	4d 2P3/2
5		12940.354	7725.651	.635	.640		4p 2P3/2	-	4d 2P1/2
22		12931.601	7730.880	.862	.862		3d 4D5/2	-(3P0)4f	(3)7/2
1		12920.360	7737.606		.578*		3d 2D5/2	-(3P2)5f	(2)5/2
2		12913.534	7741.696	.678	.677		3d 2F5/2	-(3P2)4f	(2)5/2
6		12882.627	7760.269	.251	.253		3d 4D3/2	-(3P0)4f	(3)5/2
2		12877.156	7763.566		.534*		3d 2D5/2	-(3P2)5f	(4)7/2
1		12868.938	7768.524		.537*		3d 4P5/2	-(3P0)5f	(3)7/2
3		12852.949	7778.188	.170	.169		3d 2F5/2	-(3P2)4f	(3)7/2
1		12852.429	7778.503	.485	.484		3d 2F5/2	-(3P2)4f	(3)5/2
4		12836.912	7787.905	.887	.886		3d 2F5/2	-(3P2)4f	(4)7/2
4		12809.311	7804.686	.668	.666		3d 4D7/2	-(3P1)4f	(3)7/2
1		12749.942	7841.028		.046*		3d 4P3/2	-(3P1)5f	(2)5/2
13		12747.289	7842.660	.644	.644		4p 2P1/2	-	4d 2P1/2
21		12734.971	7850.246	.228	.228		3d 4D7/2	-(3P1)4f	(4)9/2
3		12718.669	7860.308	.290	.290		3d 4D5/2	-(3P1)4f	(3)7/2
1		12685.840	7880.649		.636*		3d 2D3/2	-(3P2)5f	(2)5/2
2		12671.526	7889.551	.533	.533		3d 4D3/2	-(3P1)4f	(3)5/2
2		12632.137	7914.152		.104*		3d 4P5/2	-(3P1)5f	(3)7/2
3		12604.358	7931.594	.578	.575	(1D2)4p	2D5/2	-(1D2)3d	2D5/2
1		12576.712	7949.029	.011	.010		3d 4D3/2	-(3P1)4f	(2)3/2
11		12575.663	7949.692	.674	.675		3d 4D3/2	-(3P1)4f	(2)5/2
10		12551.020	7965.301	.283	.283		3d 4D1/2	-(3P1)4f	(2)3/2
1		12394.913	8065.619	.598	.592		3d 2P1/2	-	5p 2D3/2
2		12307.446	8122.940	.922	.920		3d 4D7/2	-(3P2)4f	(5)9/2
1		12284.056	8138.407	.406	.409		4p 2S1/2	-	5s 4P1/2
7		12268.136	8148.968	.964	.965		4s 4P3/2	-	4p 2S1/2
1		12261.437	8153.420	.402	.400		3d 4D7/2	-(3P2)4f	(2)5/2
2		12237.953	8169.066	.062	.073		4s 2P3/2	-	4p 4P1/2
1		12229.348	8174.814	.796	.804		3d 4D3/2	-(3P2)4f	(1)3/2
1		12229.103	8174.978	.960	.969		3d 4D3/2	-(3P2)4f	(1)1/2
1		12212.762	8185.916	.912	.917		4s 2P3/2	-	4p 4P3/2
11		12206.806	8189.910	.892	.893		3d 4D7/2	-(3P2)4f	(3)7/2
1	u	12205.055	8191.085	.067	.077*		3d 4D1/2	-(3P2)4f	(1)3/2
1		12204.791	8191.262	.244	.242		3d 4D1/2	-(3P2)4f	(1)1/2
42		12194.768	8197.995	.977	.977		3d 4D7/2	-(3P2)4f	(4)9/2
2		12192.337	8199.629	.611	.609		3d 4D7/2	-(3P2)4f	(4)7/2

1		12180.126	8207.850		.836*		3d	4P5/2	-(3P2)5f (1)3/2
1		12179.550	8208.238	.220	.220		3d	4D5/2	-(3P2)4f (2)3/2
6		12178.355	8209.043	.025	.024		3d	4D5/2	-(3P2)4f (2)5/2
7		12134.983	8238.383	.365	.366		3d	4D3/2	-(3P2)4f (2)3/2
3		12133.798	8239.188	.170	.171		3d	4D3/2	-(3P2)4f (2)5/2
20		12124.459	8245.534	.516	.517		3d	4D5/2	-(3P2)4f (3)7/2
6		12123.998	8245.848	.830	.832		3d	4D5/2	-(3P2)4f (3)5/2
1		12111.724	8254.204	.213	.215		4p	2S1/2	- 3d 4P3/2
8		12111.061	8254.656	.638	.640		3d	4D1/2	-(3P2)4f (2)3/2
7		12110.188	8255.251	.233	.233		3d	4D5/2	-(3P2)4f (4)7/2
10		12079.834	8275.995	.977	.979		3d	4D3/2	-(3P2)4f (3)5/2
3		12044.646	8300.173	.169	.170		4s	4P1/2	- 4p 2S1/2
2		11807.511	8466.868	.864	.864		4s	2P1/2	- 4p 4P1/2
5		11784.069	8483.711	.707	.708		4s	2P1/2	- 4p 4P3/2
2	H	11675.986	8562.243	.227	.219		4p	2D5/2	- 4d 2P3/2
56		11572.368	8638.909	.905	.906		4s	2P3/2	- 4p 2D3/2
26		11543.801	8660.287	.283	.283		4s	2P3/2	- 4p 4S3/2
11		11485.545	8704.213	.212	.212		4p	2S1/2	- 5s 2P1/2
3		11465.640	8719.324	.308	.306		4p	2D5/2	- 4d 2F5/2
49		11305.265	8843.015	.999	.996		4p	2D5/2	- 4d 2F7/2
402		11186.750	8936.700	.696	.697		4s	2P1/2	- 4p 2D3/2
764		11183.234	8939.509	.505	.505		4s	2P3/2	- 4p 2D5/2
180		11160.053	8958.078	.074	.074		4s	2P1/2	- 4p 4S3/2
12		11109.865	8998.545	.529	.527		4p	4S3/2	- 4d 2F5/2
15	H	11095.482	9010.209	.208	.215		4p	2S1/2	- 5s 2P3/2
29		11083.534	9019.923	.907	.904		4p	2D3/2	- 4d 2F5/2
9		11035.121	9059.495	.479	.482		4p	2D5/2	- 4d 4F7/2
25	H	10973.371	9110.475	.471	.470		4s	4P5/2	- 4p 4D3/2
9		10968.441	9114.570	.569	.573	(1D2)4s	2D5/2	-(1D2)4p	2D3/2
103		10967.370	9115.460	.459	.457	(1D2)4s	2D3/2	-(1D2)4p	2D3/2
134		10932.724	9144.347	.346	.347	(1D2)4s	2D5/2	-(1D2)4p	2D5/2
17		10931.666	9145.232	.231	.230	(1D2)4s	2D3/2	-(1D2)4p	2D5/2
265	H	10813.133	9245.481	.477	.475		4s	4P5/2	- 4p 4D5/2
71		10769.507	9282.933	.929	.930		4s	4P3/2	- 4p 4D1/2
435		10681.402	9359.503	.499	.500		4s	4P3/2	- 4p 4D3/2
12		10643.105	9393.181	.163	.164		3d	4F5/2	-(3P0)4f (3)7/2
3		10627.145	9407.288	.270	.271		3d	4F7/2	-(3P1)4f (3)7/2
5		10621.111	9412.632	.616	.623		4p	4P5/2	- 4d 2F7/2
415		10596.900	9434.137	.133	.135		4s	4P1/2	- 4p 4D1/2
1235		10581.569	9447.806	.802	.800		4s	4P5/2	- 4p 4D7/2
31		10575.925	9452.848	.830	.833		3d	4F7/2	-(3P1)4f (4)9/2
17		10555.218	9471.392	.374	.374		3d	4F3/2	-(3P0)4f (3)5/2
962		10529.522	9494.506	.502	.504		4s	4P3/2	- 4p 4D5/2
453		10511.584	9510.708	.704	.705		4s	4P1/2	- 4p 4D3/2
4		10499.443	9521.706	.688	.688		3d	4F5/2	-(3P1)4f (3)5/2
6		10498.449	9522.607	.589	.592		3d	4F5/2	-(3P1)4f (3)7/2
11		10456.834	9560.504	.503	.502	(1D2)4s	2D5/2	-(1D2)4p	2F5/2
132		10455.869	9561.387	.386	.386	(1D2)4s	2D3/2	-(1D2)4p	2F5/2
50		10448.360	9568.258	.240	.240		3d	4F9/2	-(3P2)4f (5)11/2
16		10447.597	9568.957	.939	.941		3d	4F5/2	-(3P1)4f (4)7/2
174		10432.655	9582.662	.661	.660	(1D2)4s	2D5/2	-(1D2)4p	2F7/2
2		10418.620	9595.571	.555	.554		4p	2D5/2	- 4d 4D7/2

11		10413.083	9600.673	.655	.654		3d	4F3/2	-(3P1)4f (3)5/2
5		10364.777	9645.418	.400	.400		3d	4F9/2	-(3P2)4f (4)9/2
1		10348.973	9660.147	.129	.131		3d	4F3/2	-(3P1)4f (2)3/2
4		10288.710	9716.728	.710	.709		3d	2P1/2	-(3P1)4f (2)3/2
7		10279.386	9725.542	.524	.525		3d	4F7/2	-(3P2)4f (5)9/2
6		10258.399	9745.439	.421	.424		3d	2P3/2	-(3P0)4f (3)5/2
1		10252.471	9751.074	.058	.058		4p	4S3/2	- 4d 4D3/2
1		10239.871	9763.072		.083*		3d	2F5/2	-(3P0)5f (3)7/2
2		10209.082	9792.516	.498	.498		3d	4F7/2	-(3P2)4f (3)7/2
2		10208.296	9793.270	.254	.251		4p	4S3/2	- 4d 4D5/2
56		10204.712	9796.710	.706	.707		4s	2P3/2	- 4p 2P1/2
2		10200.663	9800.598	.580	.582		3d	4F7/2	-(3P2)4f (4)9/2
1		10198.966	9802.229	.211	.215		3d	4F7/2	-(3P2)4f (4)7/2
7		10124.094	9874.720	.702	.704		3d	2P3/2	-(3P1)4f (3)5/2
2		10089.925	9908.160	.142	.134		3d	4F5/2	-(3P2)4f (3)5/2
229		10084.274	9913.713	.709	.711		4s	2P3/2	- 4p 2P3/2
3		10076.177	9921.679		.655*		3d	2F7/2	-(3P2)5f (5)9/2
1		10064.031	9933.653		.628*		3d	2F5/2	-(3P1)5f (4)7/2
1		10063.481	9934.196	.178	.181		3d	2P3/2	-(3P1)4f (2)3/2
3		10062.802	9934.866	.848	.846		3d	2P3/2	-(3P1)4f (2)5/2
3		10055.058	9942.518	.500	.503		3d	2P1/2	-(3P2)4f (1)3/2
1		10049.335	9948.180	.178	.181	(1D2)	4s	2D3/2	- 5p 2S1/2
1		10010.159	9987.113	.095	.100		3d	4F3/2	-(3P2)4f (3)5/2
1		9991.182	10006.083	.065	.065		3d	2P1/2	-(3P2)4f (2)3/2
67		9976.673	10020.634	.630	.627		4s	4P5/2	- 4p 4P3/2
1		9955.963	10041.479	.463	.463		4p	4P5/2	- 4d 4D3/2
5		9914.302	10083.674	.658	.656		4p	4P5/2	- 4d 4D5/2
70		9903.663	10094.506	.502	.498		4s	2P1/2	- 4p 2P1/2
1		9864.089	10135.005	.003	.015*	(1D2)	4s	2D3/2	- 5p 4D1/2
1		9839.827	10159.994	.976	.975		3d	2P3/2	-(3P2)4f (1)3/2
17		9834.791	10165.197	.181	.181		4p	4P5/2	- 4d 4D7/2
308		9796.828	10204.587	.583	.588		4s	4P5/2	- 4p 4P5/2
3		9795.264	10206.217	.201	.204		4p	4P3/2	- 4d 4D1/2
30		9790.193	10211.503	.499	.502		4s	2P1/2	- 4p 2P3/2
4		9779.122	10223.064	.048	.048		4p	4P1/2	- 4d 4D1/2
5		9776.849	10225.440	.424	.424		4p	4P3/2	- 4d 4D3/2
4		9760.771	10242.284	.268	.268		4p	4P1/2	- 4d 4D3/2
157		9750.743	10252.817	.813	.813		4s	4P3/2	- 4p 4P1/2
2		9742.810	10261.165	.147	.149		3d	2P3/2	-(3P2)4f (3)5/2
8		9736.675	10267.631	.615	.617		4p	4P3/2	- 4d 4D5/2
153		9734.750	10269.661	.657	.656		4s	4P3/2	- 4p 4P3/2
11		9706.517	10299.532	.531	.532	(1D2)	4s	2D3/2	-(1D2)4p 2P1/2
16	H	9676.237	10331.782	.781	.778	(1D2)	4s	2D5/2	-(1D2)4p 2P3/2
3		9675.394	10332.663	.662	.662	(1D2)	4s	2D3/2	-(1D2)4p 2P3/2
1		9664.199	10344.632		.597*		3d	4D7/2	-(3P1)5f (4)9/2
7		9638.925	10371.756	.740	.736		4p	4D5/2	- 4d 2F7/2
3		9628.423	10383.069	.053	.051		4p	4D3/2	- 4d 2F5/2
3		9625.787	10385.912	.896	.897		4p	4D7/2	- 4d 4F7/2
23		9609.032	10404.022	.018	.018		4s	4P1/2	- 4p 4P1/2
103		9593.501	10420.865	.861	.861		4s	4P1/2	- 4p 4P3/2
104		9563.440	10453.621	.617	.617		4s	4P3/2	- 4p 4P5/2

1		9561.164	10456.110		.129*		3d	4D1/2	-(3P1)5f	(2)3/2
4		9556.807	10460.876	.860	.856		4p	4D5/2	- 4d	4F5/2
49		9545.185	10473.613	.609	.616		4s	4P5/2	- 4p	2D3/2
23		9525.740	10494.993	.989	.993		4s	4P5/2	- 4p	4S3/2
5		9521.782	10499.356	.340	.340		4p	4D3/2	- 4d	4F3/2
34		9493.559	10530.569	.553	.555		4p	4D7/2	- 4d	4F9/2
2	b	9492.112	10532.175	.173	.156*	(1D2)	4s	2D5/2	- 5p	4P3/2
12		9452.844	10575.926	.910	.909		4p	4D1/2	- 4d	4F3/2
20		9441.853	10588.237	.221	.223		4p	4D5/2	- 4d	4F7/2
15		9435.043	10595.879	.863	.861		4p	4D3/2	- 4d	4F5/2
0		9375.775	10662.860		.842*		3d	4D7/2	-(3P2)5f	(3)7/2
1		9372.068	10667.077		.061*		3d	4D7/2	-(3P2)5f	(4)9/2
0		9327.123	10718.479		.466*		3d	4D5/2	-(3P2)5f	(3)7/2
19		9323.495	10722.650	.646	.646		4s	4P3/2	- 4p	2D3/2
26		9304.943	10744.028	.024	.022		4s	4P3/2	- 4p	4S3/2
0		9300.757	10748.864	.862	.870*	(1D2)	4s	2D3/2	- 5p	4P5/2
0					.849*		3d	4D3/2	-(3P2)5f	(3)5/2
3		9278.867	10774.221	.217	.215		4s	4P5/2	- 4p	2D5/2
1		9222.167	10840.464	.448	.444		4p	4D7/2	- 4d	4D5/2
5		9193.848	10873.854	.850	.851		4s	4P1/2	- 4p	2D3/2
4		9175.808	10895.233	.229	.228		4s	4P1/2	- 4p	4S3/2
2		9153.334	10921.983	.967	.969		4p	4D7/2	- 4d	4D7/2
1		9087.923	11000.595	.579	.576		4p	4D5/2	- 4d	4D3/2
1		9069.248	11023.247	.243	.244		4s	4P3/2	- 4p	2D5/2
1		9059.529	11035.080	.078	.073*	(1D2)	4s	2D5/2	- 5p	2D3/2
				.078	.076*		3d	4F5/2	- 6p	4P3/2
2		9058.800	11035.961	.959	.957	(1D2)	4s	2D3/2	- 5p	2D3/2
1		9053.198	11042.789	.773	.770		4p	4D5/2	- 4d	4D5/2
1		8977.745	11135.598	.582	.581		4p	4D3/2	- 4d	4D3/2
2		8872.175	11268.100	.098	.098	(1D2)	4s	2D5/2	- 5p	2D5/2
5		8741.519	11436.519	.503	.498		4p	2S1/2	- 4d	2P3/2
2		8637.574	11574.146	.130	.125		4p	2S1/2	- 4d	2P1/2
1		8613.834	11606.044	.042	.037	(1D2)	4s	2D3/2	- 5p	2P1/2

TABLE II P I lines in the region 11600 - 4000 Å.

Abbreviations: aff = affected; bl = blended; m = masked; d = diffuse; w = wide.

See also comments at the end of the table.

Starred lines (*) were not used in the least squares fit.

Parentheseses point out that the upper level is determined from this single transitio

Intensity and shape	λ_{air}(Å)	$\sigma(cm^{-1})$ Obs.	Calc.	Transition
2	11543.82	8660.27	.28*	4s 2P3/2 - 4p 4S3/2
1	11485.58	8704.19	.21*	4p 2S1/2 - 5s 2P1/2
00	11465.68	8719.29	.31*	4p 2D5/2 - 4d 2F5/2
8	11305.27	8843.01	3.00*	4p 2D5/2 - 4d 2F7/2
00	11280.05	8862.78	.82*	4p 2D3/2 - 4d 2P3/2
00 w	11192.50	8932.11	.12	4p 2D5/2 - 4d 4F5/2
14	11186.76	8936.69	.70*	4s 2P1/2 - 4p 2D3/2
16	11183.24	8939.51	.51*	4s 2P3/2 - 4p 2D5/2
00	11181.15	8941.18	.18	4p 2P1/2 -(1S2)4s 2S1/2
12	11160.06	8958.07	.07*	4s 2P1/2 - 4p 4S3/2
00	11150.03	8966.13	.11	3d 2P3/2 - 5p 2P3/2
00	11134.02	8979.02	.07*	4p 4S3/2 - 4d 2P1/2
00	11124.59	8986.63	.66*	sp42D5/2 -(3P0)5f (3)7/2
7	11109.87	8998.55	.53*	4p 4S3/2 - 4d 2F5/2
00	11107.52	9000.44	.44	4p 2D3/2 - 4d 2P1/2
9	11095.48	9010.21	.21*	4p 2S1/2 - 5s 2P3/2
9	11083.55	9019.91	.90*	4p 2D3/2 - 4d 2F5/2
0	11081.05	9021.94	.90*	3d 2F7/2 - 6p 2D5/2
6	11035.14	9059.48	.48*	4p 2D5/2 - 4d 4F7/2
8	10973.37	9110.48	.47*	4s 4P5/2 - 4p 4D3/2
8	10968.42	9114.59	.57*	(1D2)4s 2D5/2 -(1D2)4p 2D3/2
10	10967.37	9115.46	.46*	(1D2)4s 2D3/2 -(1D2)4p 2D3/2
00	10956.54	9124.47	.49	3d 4P5/2 -(3P0)6f (3)7/2
00	10947.74	9131.80	.85*	4p 4P5/2 - 4d 2P3/2
00			.87*	sp42D3/2 -(3P1)5f (2)5/2
16	10932.73	9144.34	.35*	(1D2)4s 2D5/2 -(1D2)4p 2D5/2
9	10931.68	9145.22	.23*	(1D2)4s 2D3/2 -(1D2)4p 2D5/2
2	10917.34	9157.23	.20	sp42D5/2 -(3P1)5f (4)7/2
00	10895.41	9175.66	.66	3d 4D5/2 - 6p 4D3/2
4	10853.20	9211.35	.34	4p 4S3/2 - 4d 4F5/2
5	10828.10	9232.70	.72	4p 2D3/2 - 4d 4F5/2
16	10813.13	9245.48	.48*	4s 4P5/2 - 4p 4D5/2
0	10775.39	9277.86	.88*	3d 4P5/2 -(3P1)6f (3)7/2
0			.84*	3d 4F7/2 -(3P0)4f (3)7/2
1	10762.57	9288.92	.93	4p 4P5/2 - 4d 2F5/2
1	10752.46	9297.66	.65	3d 4F9/2 -(3P1)4f (4)9/2
2	10731.53	9315.78	.81	4p 4P3/2 - 4d 2P3/2
18	10681.368	9359.53	.50*	4s 4P3/2 - 4p 4D3/2
2	10643.96	9392.43	.41	3d 4F5/2 -(3P0)4f (3)5/2
9	10643.11	9393.18	.16*	3d 4F5/2 -(3P0)4f (3)7/2

00		10628.18	9406.37	.37*	3d 4F7/2	-(3P1)4f (3)5/2
6		10627.16	9407.27	.27*	3d 4F7/2	-(3P1)4f (3)7/2
5		10621.11	9412.63	.62	4p 4P5/2	- 4d 2F7/2
16		10596.905	9434.13	.13*	4s 4P1/2	- 4p 4D1/2
19		10581.597	9447.78	.80*	4s 4P5/2	- 4p 4D7/2
10		10575.93	9452.84	.83*	3d 4F7/2	-(3P1)4f (4)9/2
2		10575.08	9453.60	.62	3d 4F7/2	-(3P1)4f (4)7/2
00		10556.45	9470.29	.28	4p 4P1/2	- 4d 2P1/2
9		10555.21	9471.40	.37*	3d 4F3/2	-(3P0)4f (3)5/2
1		10553.57	9472.87	.89	4p 4P3/2	- 4d 2F5/2
00		10551.46	9474.77	.69*	sp42D5/2	-(3P2)5f (3)7/2
1		10545.45	9480.17	.17	sp42D5/2	-(3P2)5f (4)7/2
18		10529.52	9494.51	.50*	4s 4P3/2	- 4p 4D5/2
16		10511.58	9510.71	.70*	4s 4P1/2	- 4p 4D3/2
00		10507.98	9513.97	4.03*	4p 2D5/2	- 4d 4D5/2
4		10499.46	9521.69	.69*	3d 4F5/2	-(3P1)4f (3)5/2
7		10498.47	9522.59	.59*	3d 4F5/2	-(3P1)4f (3)7/2
7		10456.85	9560.49	.50*	(1D2)4s 2D5/2	-(1D2)4p 2F5/2
16		10455.87	9561.39	.39*	(1D2)4s 2D3/2	-(1D2)4p 2F5/2
10		10448.36	9568.26	.24*	3d 4F9/2	-(3P2)4f (5)11/2
6		10447.62	9568.94	.94*	3d 4F5/2	-(3P1)4f (4)7/2
2		10446.10	9570.33	.34	3d 4F9/2	-(3P2)4f (5)9/2
18		10432.65	9582.67	.66*	(1D2)4s 2D5/2	-(1D2)4p 2F7/2
5		10418.65	9595.54	.55*	4p 2D5/2	- 4d 4D7/2
10		10413.09	9600.67	.65*	3d 4F3/2	-(3P1)4f (3)5/2
2		10375.81	9635.16	.17	3d 2F7/2	-(3P1)5f (4)9/2
3		10373.48	9637.33	.32	3d 4F9/2	-(3P2)4f (3)7/2
10		10364.78	9645.42	.40*	3d 4F9/2	-(3P2)4f (4)9/2
0		10363.06	9647.02	.03	3d 4F9/2	-(3P2)4f (4)7/2
3		10349.00	9660.12	.13*	3d 4F3/2	-(3P1)4f (2)3/2
1		10348.30	9660.78	.80	3d 4F3/2	-(3P1)4f (2)5/2
8		10288.75	9716.69	.71*	3d 2P1/2	-(3P1)4f (2)3/2
10		10279.41	9725.52	.52*	3d 4F7/2	-(3P2)4f (5)9/2
0		10272.75	9731.82	.84	4p 4S3/2	- 4d 4D1/2
9		10258.42	9745.42	.42*	3d 2P3/2	-(3P0)4f (3)5/2
4		10252.52	9751.03	.06*	4p 4S3/2	- 4d 4D3/2
00		10250.26	9753.17	.21*	4p 2D3/2	- 4d 4D1/2
1		10247.28	9756.01	.01	3d 4F7/2	-(3P2)4f (2)5/2
3	bl	10239.91	9763.03	.08*	3d 2F5/2	-(3P0)5f (3)7/2
00		10230.10	9772.40	.43*	4p 2D3/2	- 4d 4D3/2
4		10209.11	9792.49	.50*	3d 4F7/2	-(3P2)4f (3)7/2
00		10208.74	9792.84	.81	3d 4F7/2	-(3P2)4f (3)5/2
4		10208.33	9793.24	.25*	4p 4S3/2	- 4d 4D5/2
14		10204.73	9796.69	.71*	4s 2P3/2	- 4p 2P1/2
5		10200.68	9800.58	.58*	3d 4F7/2	-(3P2)4f (4)9/2
4		10199.00	9802.20	.21*	3d 4F7/2	-(3P2)4f (4)7/2
00		10186.11	9814.60	.63	4p 2D3/2	- 4d 4D5/2
00		10144.93	9854.44	.47	4p 2P3/2	- 6s 4P3/2
3		10140.64	9858.61	.63	4p 2P3/2	- 4d 2D5/2
2		10136.47	9862.66	.68	4p 2P1/2	- 4d 2D3/2
0		10128.41	9870.51	.52*	3d 4F5/2	-(3P2)4f (2)3/2

1		10127.59	9871.31	.33	3d 4F5/2	-(3P2)4f (2)5/2
10		10124.11	9874.70	.70*	3d 2P3/2	-(3P1)4f (3)5/2
0		10090.21	9907.88	.82*	3d 4F5/2	-(3P2)4f (3)7/2
2		10089.97	9908.12	.13*	3d 4F5/2	-(3P2)4f (3)5/2
2		10089.42	9908.66	.65	3d 2F5/2	-(3P1)5f (3)7/2
15		10084.28	9913.71	.71*	4s 2P3/2	- 4p 2P3/2
4		10080.40	9917.52	.53	3d 4F5/2	-(3P2)4f (4)7/2
4		10076.22	9921.64	.66	3d 2F7/2	-(3P2)5f (5)9/2
3		10064.08	9933.60	.63	3d 2F5/2	-(3P1)5f (4)7/2
1		10063.52	9934.16	.18*	3d 2P3/2	-(3P1)4f (2)3/2
4		10062.83	9934.84	.85*	3d 2P3/2	-(3P1)4f (2)5/2
6		10055.09	9942.49	.50*	3d 2P1/2	-(3P2)4f (1)3/2
3	aff	10049.37	9948.15	.18*	(1D2)4s 2D3/2	- 5p 2S1/2
2		10048.03	9949.47	.49	3d 4F3/2	-(3P2)4f (2)3/2
00		10044.11	9953.35	.41*	3d 2F7/2	-(3P2)5f (3)7/2
3	bl	10039.86	9957.57	.63*	3d 2F7/2	-(3P2)5f (4)9/2
0		10038.55	9958.87	.90	3d 2F7/2	-(3P2)5f (4)7/2
0		10036.43	9960.98	1.00	4p 2P3/2	- 6s 2P1/2
1		10010.20	9987.07	.10*	3d 4F3/2	-(3P2)4f (3)5/2
4		9991.22	10006.05	.07*	3d 2P1/2	-(3P2)4f (2)3/2
13		9976.67	10020.64	.63*	4s 4P5/2	- 4p 4P3/2
2		9955.97	10041.47	.46*	4p 4P5/2	- 4d 4D3/2
2		9919.86	10078.02	.00	4p 2P1/2	- 6s 2P1/2
9		9914.32	10083.66	.66*	4p 4P5/2	- 4d 4D5/2
14		9903.68	10094.49	.50*	4s 2P1/2	- 4p 2P1/2
4		9864.09	10135.00	.02	(1D2)4s 2D3/2	- 5p 4D1/2
4		9839.84	10159.98	.98*	3d 2P3/2	-(3P2)4f (1)3/2
13		9834.80	10165.19	.18*	4p 4P5/2	- 4d 4D7/2
2		9830.72	10169.41	.41	4p 4D7/2	- 4d 2F7/2
2		9804.70	10196.39	.39	(1D2)4s 2D5/2	- 5p 4D3/2
21		9796.85	10204.56	.59*	4s 4P5/2	- 4p 4P5/2
3		9795.27	10206.21	.20*	4p 4P3/2	- 4d 4D1/2
16		9790.21	10211.48	.50*	4s 2P1/2	- 4p 2P3/2
10		9779.11	10223.08	.05*	4p 4P1/2	- 4d 4D1/2
4		9778.65	10223.56	.54	3d 2P3/2	-(3P2)4f (2)3/2
7		9777.90	10224.34	.34	3d 2P3/2	-(3P2)4f (2)5/2
10		9776.85	10225.44	.42*	4p 4P3/2	- 4d 4D3/2
6		9772.10	10230.41	.43	3d 4D5/2	-(3P0)5f (3)7/2
10		9760.77	10242.29	.27*	4p 4P1/2	- 4d 4D3/2
20		9750.77	10252.79	.81*	4s 4P3/2	- 4p 4P1/2
1		9747.14	10256.61	.60	3d 2F5/2	-(3P2)5f (4)7/2
1		9745.34	10258.51	.53	4p 4D7/2	- 4d 4F5/2
1		9743.91	10260.01	10.00	3d 4D3/2	-(3P0)5f (3)5/2
5		9742.81	10261.17	.15*	3d 2P3/2	-(3P2)4f (3)5/2
13		9736.680	10267.62	.62*	4p 4P3/2	- 4d 4D5/2
20		9734.750	10269.66	.66*	4s 4P3/2	- 4p 4P3/2
3		9733.76	10270.71	.72	4p 2P3/2	- 6s 2P3/2
12		9706.533	10299.52	.53*	(1D2)4s 2D3/2	-(1D2)4p 2P1/2
2		9703.68	10302.54	.53	4p 4D1/2	- 4d 2P3/2
0		9686.93	10320.36	.37	3d 4D7/2	-(3P1)5f (3)7/2
7		9680.38	10327.34	.33	(1D2)4s 2D5/2	- 5p 4D5/2
15		9676.24	10331.76	.78*	(1D2)4s 2D5/2	-(1D2)4p 2P3/2

11		9675.41	10332.65	.66*	(1D2)4s	2D3/2	-(1D2)4p	2P3/2
7		9664.23	10344.60	.60		3d 4D7/2	-(3P1)5f	(4)9/2
5		9645.84	10364.32	.34		4p 4D5/2	-	4d 4F3/2
14		9638.939	10371.74	.74*		4p 4D5/2	-	4d 2F7/2
4		9634.99	10375.99	1.00		3d 4D5/2	-(3P1)5f	(3)7/2
12		9628.42	10383.07	.05*		4p 4D3/2	-	4d 2F5/2
12		9625.80	10385.90	.90*		4p 4D7/2	-	4d 4F7/2
2		9624.10	10387.73	.72		4p 2P1/2	-	6s 2P3/2
17		9609.04	10404.01	.02*		4s 4P1/2	-	4p 4P1/2
0		9607.70	10405.46	.47		3d 4D3/2	-(3P1)5f	(3)5/2
13		9593.50	10420.87	.86*		4s 4P1/2	-	4p 4P3/2
2		9576.04	10439.87	.85		3d 4D3/2	-(3P1)5f	(2)3/2
7		9575.43	10440.53	.55		3d 4D3/2	-(3P1)5f	(2)5/2
21		9563.439	10453.62	.62*		4s 4P3/2	-	4p 4P5/2
6	aff	9561.19	10456.08	.13*		3d 4D1/2	-(3P1)5f	(2)3/2
13		9556.81	10460.87	.86*		4p 4D5/2	-	4d 4F5/2
20		9545.18	10473.62	.62*		4s 4P5/2	-	4p 2D3/2
21		9525.73	10495.00	4.99*		4s 4P5/2	-	4p 4S3/2
12		9521.78	10499.36	.34*		4p 4D3/2	-	4d 4F3/2
19		9493.56	10530.57	.55*		4p 4D7/2	-	4d 4F9/2
10		9492.12	10532.17	.16	(1D2)4s	2D5/2	-	5p 4P3/2
6		9491.33	10533.04	.04	(1D2)4s	2D3/2	-	5p 4P3/2
10		9481.84	10543.58	.59	(1D2)4s	2D3/2	-	5p 4P1/2
16		9452.83	10575.94	.91*		4p 4D1/2	-	4d 4F3/2
18		9441.86	10588.23	.22*		4p 4D5/2	-	4d 4F7/2
18		9435.069	10595.85	.86*		4p 4D3/2	-	4d 4F5/2
3		9403.78	10631.10	.08		3d 4D7/2	-(3P2)5f	(5)9/2
1		9393.83	10642.36	.37		3d 4D7/2	-(3P2)5f	(2)5/2
8		9375.80	10662.83	.84		3d 4D7/2	-(3P2)5f	(3)7/2
11		9372.09	10667.05	.06		3d 4D7/2	-(3P2)5f	(4)9/2
1		9370.98	10668.32	.32		3d 4D7/2	-(3P2)5f	(4)7/2
1	bl	9369.69	10669.78	.73*		3d 4D5/2	-(3P2)5f	(1)3/2
5		9344.97	10698.01	7.99		3d 4D5/2	-(3P2)5f	(2)5/2
1		9343.32	10699.90	.88*		3d 4D3/2	-(3P2)5f	(1)3/2
				.89*		3d 4D3/2	-(3P2)5f	(1)1/2
1		9329.14	10716.16	.15*		3d 4D1/2	-(3P2)5f	(1)3/2
				.16*		3d 4D1/2	-(3P2)5f	(1)1/2
10		9327.13	10718.47	.47		3d 4D5/2	-(3P2)5f	(3)7/2
2		9325.92	10719.86	.88		4p 2D5/2	-	4d 2D3/2
15		9323.50	10722.64	.65*		4s 4P3/2	-	4p 2D3/2
1		9322.37	10723.94	.95		3d 4D5/2	-(3P2)5f	(4)7/2
3		9319.17	10727.63	.63		3d 4D3/2	-(3P2)5f	(2)3/2
1		9318.72	10728.14	.14		3d 4D3/2	-(3P2)5f	(2)5/2
	m	9304.94	10744.03	3.90*		3d 4D1/2	-(3P2)5f	(2)3/2
19				.02*		4s 4P3/2	-	4p 4S3/2
3		9301.52	10747.98	.99	(1D2)4s	2D5/2	-	5p 4P5/2
5		9300.77	10748.85	.85*		3d 4D3/2	-(3P2)5f	(3)5/2
5				.87*	(1D2)4s	2D3/2	-	5p 4P5/2
	m	9278.88	10774.21	.21*		sp42D3/2	-(3P2)6f	(2)5/2
16				.21*		4s 4P5/2	-	4p 2D5/2
2		9228.65	10832.85	.83		4p 2D5/2	-	4d 2D5/2
	m	9223.	10838.	7.96*		3d 4F5/2	-	6p 4D3/2

6	9222.17	10840.46	.44*		4p	4D7/2	-	4d 4D5/2
2	9211.93	10852.51	.50		3d	4F7/2	-	6p 4D5/2
1	9201.02	10865.38	.36	(1D2)	4s	2D3/2	-	5p 4S3/2
18	9193.85	10873.85	.85*		4s	4P1/2	-	4p 2D3/2
12	9175.819	10895.22	.23*		4s	4P1/2	-	4p 4S3/2
5	9172.60	10899.04	.03		4p	4S3/2	-	4d 4P5/2
3	9154.65	10920.41	.41		4p	2D3/2	-	4d 4P5/2
11	9153.34	10921.98	.97*		4p	4D7/2	-	4d 4D7/2
3	9142.59	10934.82	.85		4p	4S3/2	-	6s 4P1/2
1	9132.87	10946.46	(.46)		3d	4F3/2	-	6p 4D1/2
6	9128.10	10952.18	.18		3d	4F9/2	-	6p 4D7/2
5	9087.92	11000.60	.58*		4p	4D5/2	-	4d 4D3/2
1	9071.52	11020.49	.48		4p	2D3/2	-	4d 2D3/2
9	9069.27	11023.22	.24*		4s	4P3/2	-	4p 2D5/2
1	9060.31	11034.12	.12		4p	2P3/2	-	5d 2P3/2
7	9059.53	11035.07	.08*		3d	4F5/2	-	6p 4P3/2
7			.07*	(1D2)	4s	2D5/2	-	5p 2D3/2
9	9058.79	11035.97	.96*	(1D2)	4s	2D3/2	-	5p 2D3/2
9	9053.21	11042.78	.77*		4p	4D5/2	-	4d 4D5/2
2	9043.90	11054.14	.16		4p	4S3/2	-	4d 4P3/2
0	9026.42	11075.55	.53		4p	2D3/2	-	4d 4P3/2
00	8996.76	11112.06	.05		4p	4S3/2	-	4d 2D5/2
3	8993.27	11116.37	.36		4p	4D3/2	-	4d 4D1/2
00	8991.12	11119.03	.03		3d	2F5/2	-(3P0)	6f (3)7/2
00	8982.87	11129.24	.27*		4p	2D3/2	-	6s 4P3/2
00	8981.07	11131.47	.48*		4p	2P3/2	-	5d 2P1/2
5	8977.74	11135.60	.58*		4p	4D3/2	-	4d 4D3/2
00	8965.21	11151.17	.12*		4p	2P1/2	-	5d 2P3/2
0	8943.84	11177.81	.77*		4p	4D3/2	-	4d 4D5/2
0	8934.53	11189.46	.44		4p	4P5/2	-	4d 4P5/2
3	8931.75	11192.94	.93		4p	4D1/2	-	4d 4D1/2
1	8916.45	11212.15	.15		4p	4D1/2	-	4d 4D3/2
1	8914.651	11214.41	.43		4p	4S3/2	-	6s 2P1/2
2	8897.660	11235.82	.80		4p	2D3/2	-	6s 2P1/2
5	8890.452	11244.94	.92		4p	2D5/2	-	6s 2P3/2
00	8887.656	11248.47	.49		4p	2P1/2	-	5d 2P1/2
10	8872.174	11268.10	.10*	(1D2)	4s	2D5/2	-	5p 2D5/2
2	8871.488	11268.97	.98	(1D2)	4s	2D3/2	-	5p 2D5/2
00	8868.778	11272.42	.43		3d	2F5/2	-(3P1)	6f (3)7/2
2	8860.925	11282.41	.41		3d	2F7/2	-(3P2)	6f (5)9/2
1	8857.150	11287.21	.21		3d	2F5/2	-(3P1)	6f (4)7/2
4	8787.486	11376.69	.69		4p	4S3/2	-	6s 4P5/2
3	8770.917	11398.19	.30*		4p	4P5/2	-	6s 4P3/2
			.06*		4p	2D3/2	-	6s 4P5/2
3	8762.436	11409.22	.21		4p	4P3/2	-	6s 4P1/2
00	8749.529	11426.05	.06		4p	4P1/2	-	6s 4P1/2
14	8741.529	11436.51	.50*		4p	2S1/2	-	4d 2P3/2
2	8675.072	11524.12	.15		4p	4S3/2	-	6s 2P3/2
1	8673.226	11526.57	.57		4p	2D3/2	-(1D2)	3d 2F5/2
1	8671.765	11528.51	.52		4p	4P3/2	-	4d 4P3/2
3	8659.073	11545.41	.37*		4p	4P1/2	-	4d 4P3/2
3			.52*		4p	2D3/2	-	6s 2P3/2

00		8645.582	11563.43	.43		3d	2P1/2	-	6p 2P1/2
0		8642.061	11568.14	.12		3d	4F5/2	-	6p 2P3/2
12		8637.578	11574.14	.13*		4p	2S1/2	-	4d 2P1/2
3		8631.514	11582.27	.26		4p	4P3/2	-	6s 4P3/2
2		8628.469	11586.36	.42*		4p	4P3/2	-	4d 2D5/2
2				.38*		3d	4D5/2	-(3P0)6f	(3)7/2
3		8618.976	11599.12	.11		4p	4P1/2	-	6s 4P3/2
11		8613.835	11606.04	.04*	(1D2)	4s	2D3/2	-	5p 2P1/2
7		8568.755	11667.10	.09		4p	4P5/2	-	6s 4P5/2
3		8545.863	11698.35	.36		3d	4D7/2	-(3P1)6f	(4)9/2
1	bl	8537.489	11709.83	.87*		4p	2S1/2	-	4d 4F3/2
11	aff	8531.475	11718.08	.12*	(1D2)	4s	2D5/2	-	5p 2P3/2
8		8530.785	11719.03	.01*	(1D2)	4s	2D3/2	-	5p 2P3/2
00	d	8515.780	11739.68	.77*		3d	4D5/2	-(3P1)6f	(3)7/2
00	d	8479.268	11790.23	.22*		3d	4D3/2	-(3P1)6f	(2)3/2
2		8478.877	11790.78	.76		3d	4D3/2	-(3P1)6f	(2)5/2
1		8470.630	11802.26	.27		3d	2P3/2	-	6p 2D5/2
2		8467.599	11806.48	.50		3d	4D1/2	-(3P1)6f	(2)3/2
2		8435.759	11851.04	.05		4p	4P3/2	-	6s 4P5/2
00		8414.890	11880.43	.45		4s	4P3/2	-	4p 2P1/2
00	d	8411.632	11885.03	.07*		4p	4P5/2	-(1D2)3d	2F7/2
1		8406.595	11892.16	.15		3d	4F5/2	-(3P0)5f	(3)5/2
5		8406.185	11892.73	.73		3d	4F5/2	-(3P0)5f	(3)7/2
0	d	8386.145	11921.15	.14		3d	2P3/2	-	6p 2P3/2
3		8384.840	11923.01	2.98		3d	4F7/2	-(3P1)5f	(3)7/2
10		8367.856	11947.21	.20		3d	4F7/2	-(3P1)5f	(4)9/2
2	d	8367.343	11947.94	.96		3d	4F7/2	-(3P1)5f	(4)7/2
9		8351.140	11971.12	.12		3d	4F3/2	-(3P0)5f	(3)5/2
00	d	8336.680	11991.89	.83*		3d	4D7/2	-(3P2)6f	(5)9/2
0		8332.800	11997.47	.45		4s	4P3/2	-	4p 2P3/2
0		8332.065	11998.53	.51		4p	4P3/2	-	6s 2P3/2
3		8325.268	12008.32	.32		4p	2D5/2	-	5d 2P3/2
2		8324.653	12009.21	.23		3d	4D7/2	-(3P2)6f	(3)7/2
3		8322.829	12011.84	.86		3d	4D7/2	-(3P2)6f	(4)9/2
1		8320.394	12015.36	.36		4p	4P1/2	-	6s 2P3/2
3		8305.001	12037.63	.63		3d	4F5/2	-(3P1)5f	(3)5/2
5		8304.522	12038.32	.30		3d	4F5/2	-(3P1)5f	(3)7/2
1	d	8294.582	12052.75	.74		3d	4D5/2	-(3P2)6f	(2)5/2
9		8287.338	12063.29	.28		3d	4F5/2	-(3P1)5f	(4)7/2
2	d	8286.247	12064.87	.86		3d	4D5/2	-(3P2)6f	(3)7/2
0	w	8283.898	12068.30	.32		3d	4D5/2	-(3P2)6f	(4)7/2
1	d	8280.875	12072.70	.70		3d	4F5/2	-(3P1)5f	(2)5/2
11		8278.058	12076.81	(.81)		3d	4F9/2	-(3P2)5f	(5)11/2
2		8276.903	12078.49	.51		3d	4F9/2	-(3P2)5f	(5)9/2
0	d	8274.184	12082.46	.46		3d	4D3/2	-(3P2)6f	(2)3/2
00		8273.896	12082.88	.88		3d	4D3/2	-(3P2)6f	(2)5/2
0	aff	8266.935	12093.06	.15*		3d	2F5/2	-(3P1)7f	(3)7/2
2		8265.488	12095.18	.21*		4p	2P3/2	-	5d 2F5/2
				.18*		3d	4D3/2	-(3P2)6f	(3)5/2
1		8263.061	12098.73	.73		3d	4D1/2	-(3P2)6f	(2)3/2
1		8261.034	12101.70	.70		3d	2F7/2	-(3P2)7f	(5)9/2

0	w	8260.465	12102.53	(.53)	3d	2F5/2	-(3P1)7f (4)7/2
1		8255.181	12110.28	.27	3d	4F9/2	-(3P2)5f (3)7/2
5		8252.312	12114.49	.48	3d	4F9/2	-(3P2)5f (4)9/2
6		8250.871	12116.60	.59	3d	4F3/2	-(3P1)5f (3)5/2
2		8229.182	12148.54	.55	4p	4D5/2	- 4d 4P5/2
2	bl	8227.584	12150.90	.98*	3d	4F3/2	-(3P1)5f (2)3/2
4		8189.413	12207.53	.55	3d	2P1/2	-(3P1)5f (2)3/2
00		8186.840	12211.37	.33*	4p	2P3/2	- 5d 2D3/2
00		8180.870	12220.28	.34*	4p	2P3/2	- 5d 4P5/2
6		8171.896	12233.70	.69	3d	4F7/2	-(3P2)5f (5)9/2
5		8164.242	12245.17	.17	3d	2P3/2	-(3P0)5f (3)5/2
2		8161.930	12248.64	.62	4p	4D5/2	- 4d 2D3/2
3		8150.743	12265.45	.45	3d	4F7/2	-(3P2)5f (3)7/2
4		8147.937	12269.67	.67	3d	4F7/2	-(3P2)5f (4)9/2
3		8147.086	12270.95	.93	3d	4F7/2	-(3P2)5f (4)7/2
4		8125.405	12303.70	.68	4p	4D5/2	- 4d 4P3/2
4		8115.059	12319.38	.37	4p	4D3/2	- 6s 4P1/2
2		8110.105	12326.91	.90	4p	2S1/2	- 4d 4D1/2
3		8109.164	12328.34	.33	4p	2P1/2	- 5d 2D3/2
0		8102.718	12338.15	.19*	4p	2P3/2	- 5d 4P3/2
2		8097.490	12346.11	.12	4p	2S1/2	- 4d 4D3/2
8		8090.068	12357.44	.41	4p	4D5/2	- 6s 4P3/2
00		8088.212	12360.27	.29*	3d	4F5/2	-(3P2)5f (2)5/2
3		8074.665	12381.01	.00	3d	4F5/2	-(3P2)5f (3)5/2
1	d	8072.115	12384.92	.91	4p	4S3/2	- 5d 2P1/2
4		8071.242	12386.26	.25	3d	4F5/2	-(3P2)5f (4)7/2
6		8068.385	12390.65	.65	3d	2P3/2	-(3P1)5f (3)5/2
5		8064.936	12395.95	.94	4p	4D1/2	- 6s 4P1/2
00		8061.366	12401.44	.48	4p	2D5/2	- 5d 4F7/2
1		8060.398	12402.93	.94	3d	4D5/2	-(3P0)7f (3)7/2
2		8058.222	12406.27	.29	4p	2D3/2	- 5d 2P1/2
0		8056.200	12409.39	.42*	4p	2P1/2	- 7s 4P3/2
10		8046.801	12423.88	.88	4p	4D7/2	- 6s 4P5/2
2	aff	8046.076	12425.00	.03*	3d	2P3/2	-(3P1)5f (2)3/2
3		8045.620	12425.71	.72	3d	2P3/2	-(3P1)5f (2)5/2
4		8043.509	12428.97	.98	4p	2P3/2	- 5d 2D5/2
4		8037.233	12438.67	.68	4p	4D3/2	- 4d 4P3/2
1	d	8023.486	12459.98	.97	3d	4F3/2	-(3P2)5f (3)5/2
4		8023.033	12460.69	.70	4p	2P3/2	-(1D2)3d 2P3/2
5		8018.629	12467.53	.58*	3d	2P1/2	-(3P2)5f (1)3/2
				.59*	3d	2P1/2	-(3P2)5f (1)1/2
6		8002.652	12492.42	.42	4p	4D3/2	- 6s 4P3/2
4		8000.805	12495.31	.33	3d	2P1/2	-(3P2)5f (2)3/2
1		7998.914	12498.26	.32*	(1D2)4s	2D3/2	-(3P0)4f (3)5/2
				.19*	(1D2)4s	2D5/2	-(3P0)4f (3)7/2
2	d	7988.965	12513.82	.84	3d	4D7/2	-(3P1)7f (4)9/2
1		7955.084	12567.12	.13	4p	2P3/2	-(1D2)3d 2S1/2
00		7954.873	12567.45	.46	4p	4S3/2	- 5d 4F5/2
3		7953.916	12568.97	.99	4p	4D1/2	- 6s 4P3/2
3		7943.964	12584.71	.73	4p	2P3/2	-(1D2)3d 2P1/2
2		7934.984	12598.95	.95	4p	4D3/2	- 6s 2P1/2
1		7931.748	12604.09	.11	3d	4D3/2	-(3P1)7f (2)5/2

5		7917.862	12626.20	.21		4p	4D5/2	-	6s 4P5/2
00		7913.780	12632.71	(.71)		3d	2F7/2	-(3P2)	8f (5)9/2
1		7888.022	12673.96	.97	(1D2)	4s	2D5/2	-(3P1)	4f (4)7/2
2		7887.058	12675.51	.52		4p	4D1/2	-	6s 2P1/2
4		7881.693	12684.14	.13		4p	2P1/2	-(1D2)	3d 2S1/2
3		7881.163	12684.99	5.06*		3d	2P3/2	-(3P2)	5f (1)1/2
				5.05*		3d	2P3/2	-(3P2)	5f (1)3/2
1		7879.465	12687.73	.74	(1D2)	4s	2D3/2	-(3P1)	4f (2)5/2
2		7870.770	12701.74	.73		4p	2P1/2	-(1D2)	3d 2P1/2
2		7863.918	12712.81	.80		3d	2P3/2	-(3P2)	5f (2)3/2
4		7863.610	12713.31	.31		3d	2P3/2	-(3P2)	5f (2)5/2
3		7858.204	12722.05	.06		4p	2P3/2	-	7s 2P3/2
5		7850.822	12734.02	.02		3d	2P3/2	-(3P2)	5f (3)5/2
0		7841.076	12749.84	.84		4p	2D5/2	-	5d 4D7/2
1		7833.670	12761.90	.91		4p	4P3/2	-	5d 2P3/2
3		7826.447	12773.68	.66		4p	4D5/2	-	6s 2P3/2
2	d	7796.135	12823.34	.36		3d	4D7/2	-(3P2)	7f (4)9/2
3		7783.483	12844.18	(.18)		4p	4D5/2	-(1D2)	3d 2F7/2
0		7767.028	12871.40	(.40)		3d	4D5/2	-(3P2)	7f (2)5/2
1	w	7764.122	12876.21	.12*		4p	4P1/2	-	5d 2P1/2
				.30*		3d	4D5/2	-(3P2)	7f (3)7/2
0	d	7762.177	12879.44	.46		3d	4D5/2	-(3P2)	7f (4)7/2
3		7759.520	12883.85	.84		4p	4S3/2	-	5d 4D3/2
2		7755.990	12889.71	.71		4p	4D3/2	-(1D2)	3d 2F5/2
00		7749.096	12901.18	.16		3d	4D3/2	-(3P2)	7f (2)3/2
00		7745.868	12906.56	.54		3d	4D3/2	-(3P2)	7f (3)5/2
2		7744.601	12908.67	.67		4p	4D3/2	-	6s 2P3/2
0		7742.080	12912.87	.87	(1D2)	4s	2D3/2	-(3P2)	4f (1)3/2
1		7733.551	12927.11	.12		4p	4S3/2	-	5d 4D5/2
00		7720.785	12948.49	.49		4p	2D3/2	-	5d 4D5/2
4		7707.319	12971.11	.11		4p	4P5/2	-	5d 4F7/2
1		7703.684	12977.23	.23	(1D2)	4s	2D3/2	-(3P2)	4f (2)5/2
0		7702.560	12979.12	.10		4p	4P3/2	-	5d 4F3/2
00		7698.960	12985.19	.24*		4p	4D1/2	-	6s 2P3/2
0		7693.241	12994.85	.83		4p	4D5/2	-(1D2)	3d 2G7/2
00		7692.575	12995.97	.94		4p	4P1/2	-	5d 4F3/2
00		7682.601	13012.84	.84	(1D2)	4s	2D5/2	-(3P2)	4f (3)7/2
0		7681.900	13014.03	.04	(1D2)	4s	2D3/2	-(3P2)	4f (3)5/2
2		7676.881	13022.54	.56	(1D2)	4s	2D5/2	-(3P2)	4f (4)7/2
2		7665.534	13041.82	.82		4p	4P3/2	-	5d 4F5/2
00		7664.990	13042.74	.74		3d	4D7/2	-(3P1)	8f (4)9/2
1		7588.470	13174.26	.24		4p	4P5/2	-	5d 4D3/2
00		7581.990	13185.52	.53		4p	2D5/2	-	5d 2D3/2
1		7579.871	13189.21	.19		4p	2P3/2	-	6d 2P3/2
2		7568.726	13208.63	.62		4p	2P3/2	-(1D2)	5s 2D5/2
1		7565.220	13214.75	.74		4p	2P3/2	-(1D2)	5s 2D3/2
4		7563.623	13217.54	.52		4p	4P5/2	-	5d 4D5/2
3		7545.828	13248.71	.68		3d	4F5/2	-(3P0)	6f (3)7/2
1	d	7524.213	13286.77	.76		3d	4F7/2	-(3P1)	6f (3)7/2
5		7516.175	13300.98	.97		3d	4F7/2	-(3P1)	6f (4)9/2
2		7513.230	13306.19	.19		4p	2P1/2	-	6d 2P3/2
00		7509.510	13312.78	.77		4p	2P1/2	-	6d 4D1/2

8		7505.744	13319.46	.47	4p 4P5/2 - 5d 4D7/2
3		7501.289	13327.37	.38	3d 4F3/2 -(3P0)6f (3)5/2
1		7501.124	13327.67	.68	4p 2P3/2 - 6d 4D3/2
00		7498.825	13331.75	.74	4p 2P1/2 -(1D2)5s 2D3/2
2		7496.250	13336.33	.31	4p 4P3/2 - 5d 4D1/2
6		7490.083	13347.31	.30	4p 2D5/2 - 5d 2F7/2
4		7489.329	13348.66	.64	4p 4S3/2 - 5d 2F5/2
1	d	7487.475	13351.96	(.96)	3d 4D7/2 -(3P2)8f (4)9/2
6		7486.795	13353.17	.15	4p 4P1/2 - 5d 4D1/2
6		7483.969	13358.21	.20	4p 4P3/2 - 5d 4D3/2
3		7477.361	13370.02	.02	4p 2D3/2 - 5d 2F5/2
5		7474.546	13375.06	.05	4p 4P1/2 - 5d 4D3/2
0		7468.530	13385.83	.81	4p 4S3/2 - 7s 4P1/2
5		7459.812	13401.47	.48	4p 4P3/2 - 5d 4D5/2
2		7459.471	13402.08	.08	3d 4F5/2 -(3P1)6f (3)7/2
1		7458.849	13403.20	.19	4p 2D5/2 - 5d 2D5/2
4		7451.264	13416.85	.86	3d 4F5/2 -(3P1)6f (4)7/2
0	w	7444.690	13428.69	.65*	4p 2P3/2 - 6d 2P1/2
6		7439.489	13438.08	(.08)	3d 4F9/2 -(3P2)6f (5)11/2
0		7435.824	13444.71	.68	4p 2P1/2 - 6d 4D3/2
2		7427.757	13459.31	.29	3d 4F9/2 -(3P2)6f (4)9/2
1		7419.788	13473.76	.76	4p 4S3/2 - 5d 4P5/2
3		7416.042	13480.57	.57	3d 4F3/2 -(3P1)6f (3)5/2
0	w	7412.949	13486.19	.13*	4p 2D3/2 - 5d 2D3/2
3		7408.038	13495.13	.14	4p 2D3/2 - 5d 4P5/2
2		7388.994	13529.92	.91	4p 2S1/2 - 6s 4P1/2
1	w	7380.380	13545.71	.85*	4p 4S3/2 - 7s 4P3/2
				.66*	4p 2P1/2 - 6d 2P1/2
2		7373.715	13557.95	.92	3d 2P1/2 -(3P1)6f (2)3/2
2		7372.925	13559.40	.38	4p 2D3/2 - 7s 2P1/2
0		7368.665	13567.24	.22	4p 2D3/2 - 7s 4P3/2
3		7355.454	13591.61	.62	4p 4S3/2 - 5d 4P3/2
5		7353.922	13594.44	.44	3d 4F7/2 -(3P2)6f (5)9/2
4		7350.142	13601.43	.43	3d 2P3/2 -(3P0)6f (3)5/2
1	d	7344.510	13611.86	.84	3d 4F7/2 -(3P2)6f (3)7/2
2		7343.897	13613.00	1.00	4p 2D3/2 - 5d 4P3/2
2		7343.115	13614.45	.47	3d 4F7/2 -(3P2)6f (4)9/2
1		7342.643	13615.32	.30	3d 4F7/2 -(3P2)6f (4)7/2
1		7329.876	13639.04	.05	4p 4P5/2 - 5d 2F5/2
3		7324.408	13649.22	.21	4p 2S1/2 - 4d 4P3/2
3		7311.400	13673.50	.50	4p 4S3/2 - 5d 4P1/2
3		7309.746	13676.60	.60	4p 2P3/2 - 6d 2D3/2
2		7306.635	13682.42	.41	4p 4S3/2 - 5d 2D5/2
0		7299.995	13694.87	.87	4p 2D3/2 - 5d 4P1/2
4		7299.244	13696.28	.26	4p 2D5/2 - 7s 2P3/2
00	d	7290.964	13711.83	(.83)	3d 4D7/2 -(3P2)9f (4)9/2
00		7282.714	13727.36	.34	3d 4F5/2 -(3P2)6f (3)5/2
5	aff	7282.410	13727.94	.90*	4p 4D7/2 - 5d 4F7/2
	m	7281.	13730.	.62*	3d 4F5/2 -(3P2)6f (4)7/2
1		7271.445	13748.64	.64	4p 4D1/2 - 5d 2P3/2
0	aff	7268.453	13754.30	.25*	4p 4D5/2 - 5d 4F3/2
5		7268.283	13754.62	.62	3d 2P3/2 -(3P1)6f (3)5/2

4		7263.238	13764.17	.17		4p	4P5/2	-	5d 4P5/2
0		7260.460	13769.44	.44		4p	4D3/2	-	5d 2P1/2
	bl	7257.363	13775.31	.40*		3d	2P3/2	-(3P1)6f	(2)3/2
2		7257.050	13775.91	.93		3d	2P3/2	-(3P1)6f	(2)5/2
0		7247.737	13793.61	.61		4p	2P1/2	-	6d 2D3/2
	m	7245.	13800.	.21*		4p	2P1/2	-	8s 2P1/2
3		7243.342	13801.98	2.00		4p	2P3/2	-	6d 2D5/2
5		7239.411	13809.47	.48		4p	2S1/2	-	6s 2P1/2
6		7235.487	13816.96	.98		4p	4D5/2	-	5d 4F5/2
5		7226.281	13834.56	.56		3d	2P1/2	-(3P2)6f	(1)
2		7225.403	13836.24	.25		4p	4P5/2	-	7s 4P3/2
2		7224.399	13838.17	.16		4p	4S3/2	-(1D2)3d	2P1/2
2		7222.434	13841.93	.93		4p	2D3/2	-(1D2)3d	2S1/2
3		7221.011	13844.66	.65		4p	4S3/2	-	7s 4P5/2
0		7220.308	13846.01	.01		4p	4D1/2	-	5d 2P1/2
2		7218.145	13850.16	.15		3d	2P1/2	-(3P2)6f	(2)3/2
2		7213.225	13859.60	.54*		4p	2D3/2	-(1D2)3d	2P1/2
4		7212.929	13860.17	.18		4p	4P3/2	-	7s 4P1/2
2		7209.880	13866.04	.03		4p	2D3/2	-	7s 4P5/2
2		7201.566	13882.04	.03		4p	4P5/2	-	5d 4P3/2
8		7197.823	13889.26	.26		4p	4D3/2	-	5d 4F3/2
00		7178.350	13926.94	.91		4p	2P3/2	-	8s 4P5/2
12		7176.660	13930.22	.22		4p	4D5/2	-	5d 4F7/2
12		7175.102	13933.24	.24		4p	4D7/2	-	5d 4F9/2
0		7169.630	13943.88	.87	(1D2)4s		2D3/2	-	6p 4D3/2
12		7165.465	13951.98	.98		4p	4D3/2	-	5d 4F5/2
10		7158.367	13965.82	.83		4p	4D1/2	-	5d 4F3/2
3		7154.790	13972.79	.81		4p	4P5/2	-	5d 2D5/2
4		7154.012	13974.32	.31		4p	4D7/2	-	5d 4D5/2
1		7153.408	13975.50	.48		4p	4S3/2	-	7s 2P3/2
1		7152.980	13976.33	.35		4p	2P3/2	-	8s 2P3/2
1		7142.493	13996.85	.86		4p	2D3/2	-	7s 2P3/2
0		7134.596	14012.35	.37		4p	4P3/2	-	7s 2P1/2
2		7130.598	14020.20	.21		4p	4P3/2	-	7s 4P3/2
2		7122.044	14037.04	.06		4p	4P1/2	-	7s 4P3/2
1		7114.450	14052.03	.03		3d	2P3/2	-(3P2)6f	(1)
2	bl	7107.731	14065.31	.24*		3d	4F5/2	-(3P0)7f	(3)7/2
00		7106.564	14067.62	.63		3d	2P3/2	-(3P2)6f	(2)3/2
1		7106.339	14068.06	.06		3d	2P3/2	-(3P2)6f	(2)5/2
1		7103.930	14072.84	.84	(1D2)4s		2D5/2	-	6p 4D5/2
10		7102.200	14076.26	.25		4p	4D7/2	-	5d 4D7/2
2		7100.148	14080.33	.35		3d	2P3/2	-(3P2)6f	(3)5/2
0	d	7086.405	14107.64	.70*		4p	2P3/2	-(1D2)3d	2D3/2
3		7081.977	14116.46	.44		3d	4F7/2	-(3P1)7f	(4)9/2
6		7080.591	14119.22	.20		4p	2S1/2	-	6s 2P3/2
3		7073.521	14133.33	.36		4p	4D5/2	-	5d 4D3/2
3		7072.662	14135.05	.06		4p	4P5/2	-	7s 4P5/2
2	bl	7069.600	14141.17	.10*	(1D2)4s		2D5/2	-	6p 4P3/2
0		7068.180	14144.01	.00		3d	4F3/2	-(3P0)7f	(3)5/2
1		7067.710	14144.95	.97		4p	2P3/2	-(1D2)3d	2D5/2
1	d	7058.553	14163.30	.29		4p	2P3/2	-	7d 2P3/2

6		7051.920	14176.63	.64		4p 4D5/2	-	5d 4D5/2
2		7048.838	14182.82	.83		4p 2D5/2	-(1D2)5s	2D5/2
00		7046.018	14188.50	.49		4p 4P3/2	-(1D2)3d	2P3/2
0		7037.665	14205.34	.33		4p 4P1/2	-(1D2)3d	2P3/2
1		7029.030	14222.79	.80		3d 4F5/2	-(3P1)7f	(3)7/2
0	bl	7024.339	14232.29	.18*		3d 4F5/2	-(3P1)7f	(4)7/2
2		7017.349	14246.47	.47		4p 4D3/2	-	5d 4D1/2
3		7011.801	14257.74	(.74)		3d 4F9/2	-(3P2)7f	(5)11/2
2		7011.553	14258.24	.25	(1D2)4s	2D5/2	-	6p 2D3/2
3		7011.122	14259.12	.14	(1D2)4s	2D3/2	-	6p 2D3/2
4		7006.583	14268.36	.36		4p 4D3/2	-	5d 4D3/2
0		7005.382	14270.80	.78		3d 4F9/2	-(3P2)7f	(4)9/2
2		7001.566	14278.58	.58		4p 4D5/2	-	5d 4D7/2
0	d	7000.696	14280.36	.29*		4p 2P1/2	-	7d 2P3/2
2		6990.203	14301.79	.78		3d 4F3/2	-(3P1)7f	(3)5/2
0		6985.400	14311.62	.64		4p 4D3/2	-	5d 4D5/2
0	d	6981.815	14318.97	9.02*		4p 4P3/2	-	7s 4P5/2
3		6979.840	14323.03	.04		4p 4D1/2	-	5d 4D1/2
00		6940.172	14404.89	.86*	(1D2)4s	2D5/2	-	6p 4P5/2
1		6935.911	14413.74	.73		3d 4F7/2	-(3P2)7f	(5)9/2
0	d	6933.842	14418.04	.05		3d 2P3/2	-(3P0)7f	(3)5/2
00		6917.888	14451.29	.33*		sp44P1/2	-(1D2)4p	2D3/2
00		6912.760	14462.01	.05		4p 4S3/2	-(1D2)5s	2D5/2
00		6909.860	14468.08	.16*		4p 4S3/2	-(1D2)5s	2D3/2
0		6902.533	14483.44	.43		4p 2D3/2	-(1D2)5s	2D5/2
00		6899.630	14489.53	.54		4p 2D3/2	-(1D2)5s	2D3/2
0	w	6884.722	14520.91	.96*		4p 4D7/2	-	5d 4P5/2
3		6878.613	14533.81	.80	(1D2)4s	2D3/2	-	6p 2P1/2
00		6876.307	14538.68	.69		3d 4F5/2	-(3P2)7f	(3)5/2
00		6874.838	14541.79	.76		3d 4F5/2	-(3P2)7f	(4)7/2
5		6868.938	14554.28	.28	(1D2)4s	2D5/2	-	6p 2D5/2
00		6868.520	14555.16	.17	(1D2)4s	2D3/2	-	6p 2D5/2
0		6858.783	14575.82	.83		3d 2P3/2	-(3P1)7f	(3)5/2
1		6857.110	14579.38	.39		4p 4P5/2	-	6d 4F5/2
2	d	6826.225	14645.34	.34		3d 4F7/2	-(3P1)8f	(4)9/2
00		6821.063	14656.43	.43		3d 2P1/2	-(3P2)7f	(1)
1		6816.966	14665.23	.24		4p 2P3/2	-	7d 2D5/2
00	d	6815.296	14668.83	.86		3d 2P1/2	-(3P2)7f	(2)3/2
4		6813.291	14673.15	.15	(1D2)4s	2D5/2	-	6p 2P3/2
3	bl	6812.868	14674.06	.03*	(1D2)4s	2D3/2	-	6p 2P3/2
8		6809.540	14681.23	.24		4p 2D5/2	-	6d 2F7/2
4		6806.612	14687.54	.56		4p 4S3/2	-	6d 2F5/2
4		6796.718	14708.92	.93		4p 2D3/2	-	6d 2F5/2
0		6796.387	14709.64	.66		4p 4P3/2	-	6d 4F3/2
1	w	6788.604	14726.51	.50		4p 4P1/2	-	6d 4F3/2
1	w	6785.563	14733.10	.02*		4p 4P5/2	-	6d 2P3/2
				.17*		4p 4D3/2	-	5d 2F5/2
0		6780.542	14744.01	3.99		4p 4S3/2	-	8s 4P1/2
0	w	6775.860	14754.20	(.20)		3d 4F5/2	-(3P1)8f	(3)7/2
0		6772.758	14760.96	(.96)		3d 4F5/2	-(3P1)8f	(4)7/2
3		6771.661	14763.35	.35		4p 4P3/2	-	6d 4F5/2
3		6708.457	14770.34	.34		4p 4D3/2	-	7s 4P1/2

3	w	6759.930	14788.97	(.97)	3d	4F9/2	-(3P2)	8f	(5)11/2
5		6756.999	14795.39	.36	4p	4D5/2	-	7s	4P3/2
1	d	6739.810	14833.12	.13	3d	4F3/2	-(3P1)	8f	(3)5/2
1	bl	6736.203	14841.06	.14*	4p	4D5/2	-	5d	4P3/2
3		6733.552	14846.91	.91	4p	4D1/2	-	7s	4P1/2
3		6728.381	14858.31	.32	4p	4P5/2	-	6d	4D5/2
00	w	6722.432	14871.46	.51*	4p	4P5/2	-	6d	4D3/2
2		6720.367	14876.03	.04	4p	4D5/2	-	5d	2F7/2
10		6717.411	14882.58	.60	4p	2S1/2	-	5d	2P3/2
1	aff	6716.196	14885.27	.32*	4p	4S3/2	-	6d	4P5/2
	m	6713.	14891.	.84*	4p	4D7/2	-	7s	4P5/2
	m			.71*	3d	2P3/2	-(3P2)	7f	(3)5/2
2		6706.549	14906.68	.69	4p	2D3/2	-	6d	4P5/2
1		6701.929	14916.96	.98	4p	4P3/2	-	6d	2P3/2
0		6697.945	14925.83	.85	4p	4D1/2	-	5d	2D3/2
3		6695.918	14930.35	.37	4p	4D3/2	-	7s	4P3/2
1		6693.203	14936.41	.42	4p	4P3/2	-(1D2)	5s	2D5/2
2		6691.419	14940.39	.40	4p	4P1/2	-	6d	4D1/2
00		6690.450	14942.55	.53	4p	4P3/2	-(1D2)	5s	2D3/2
0	d	6686.882	14950.53	.56	4p	2D5/2	-	8s	2P3/2
	m	6684.	14958.	.01*	4p	2D3/2	-	8s	2P1/2
7		6673.731	14979.99	.97	4p	2S1/2	-	5d	2P1/2
4		6669.237	14990.08	.08	4p	4P5/2	-	6d	4D7/2
0		6665.243	14999.06	.09	4p	4D1/2	-	7s	2P1/2
1		6662.136	15006.06	.09	4p	4S3/2	-	6d	4P3/2
00		6652.655	15027.44	.46	4p	2D3/2	-	6d	4P3/2
4		6646.088	15042.29	.28	4p	4P3/2	-	6d	4D5/2
3		6640.270	15055.47	.43*	4p	4S3/2	-	6d	2D5/2
				.47*	4p	4P3/2	-	6d	4D3/2
1		6637.531	15061.68	.69	4p	4S3/2	-	6d	4P1/2
1		6635.248	15066.87	.93*	4p	4D3/2	-	5d	2D5/2
2		6632.855	15072.30	.31	4p	4P1/2	-	6d	4D3/2
00		6628.123	15083.06	.06	4p	2D3/2	-	6d	4P1/2
3		6623.245	15094.17	.17	4p	4D5/2	-	7s	4P5/2
0		6621.290	15098.63	.65	4p	4D3/2	-(1D2)	3d	2P3/2
1		6620.788	15099.77	.79	4p	2S1/2	-	5d	4F3/2
1		6617.540	15107.18	.18	3d	2P3/2	-(3P1)	8f	(3)5/2
1		6616.189	15110.27	.28	4p	2D5/2	-	7d	4F7/2
4		6612.281	15119.20	.18	4p	2D5/2	-(1D2)	3d	2D5/2
1	w	6597.608	15152.82	(.82)	3d	4F9/2	-(3P2)	9f	(5)11/2
1		6593.640	15161.94	.92	4p	4P3/2	-	6d	2F5/2
2		6588.713	15173.28	.29	4p	4P1/2	-	6d	2P1/2
1		6587.855	15175.26	.22*	4p	4D1/2	-(1D2)	3d	2P3/2
				.30*	4p	4P5/2	-	8s	4P3/2
3		6587.642	15175.75	.72	4p	4P5/2	-	6d	4P5/2
1		6585.652	15180.33	.34	4p	4S3/2	-	8s	4P5/2
1		6566.339	15224.98	5.00	4p	4D5/2	-	7s	2P3/2
0		6564.540	15229.15	.17	4p	4D3/2	-	7s	4P5/2
0		6561.943	15235.18	.20	4p	4P1/2	-	8s	4P1/2
1		6535.639	15296.50	.49	4p	4P5/2	-	6d	4P3/2
0		6534.529	15299.09	.10	4p	2D3/2	-	7d	4F5/2
00		6518.720	15336.20	.18	4p	4D7/2	-	6d	4F5/2

1	aff	6508.725	15359.75	.68*		4p	4P3/2	-	6d 4P5/2
1	aff	6499.118	15382.45	.50*		4p	2D3/2	-(1D2)	3d 2D3/2
0		6484.687	15416.69	.72		4p	4S3/2	-	7d 2P3/2
1		6475.697	15438.09	.09		4p	2D3/2	-	7d 2P3/2
1		6472.245	15446.32	.30		4p	4D7/2	-	6d 4F7/2
1		6467.774	15457.00	7.00		4p	2S1/2	-	5d 4D1/2
0		6464.307	15465.29	.32	(1D2)	4s	2D5/2	-(3P2)	5f (2)5/2
1		6457.973	15480.46	.45		4p	4P3/2	-	6d 4P3/2
1		6453.468	15491.26	.27	(1D2)	4s	2D5/2	-(3P2)	5f (4)7/2
00		6441.433	15520.21	.19		4p	4P5/2	-	8s 2P3/2
4		6438.803	15526.55	.54		4p	2D5/2	-	7d 2F7/2
00		6436.720	15531.57	.65*		4p	4P5/2	-	7d 4F3/2
2		6433.845	15538.51	.51		4p	4D5/2	-	6d 4F5/2
2		6433.166	15540.15	.15		4p	4S3/2	-	7d 2F5/2
3		6424.322	15561.54	.53		4p	2D3/2	-	7d 2F5/2
4		6400.350	15619.83	.82		4p	4D3/2	-	6d 4F3/2
2		6392.370	15639.45	.44		4p	2D5/2	-	7d 2D5/2
10		6388.579	15648.61	.63		4p	4D5/2	-	6d 4F7/2
8		6378.425	15673.52	.51		4p	4D3/2	-	6d 4F5/2
1	bl	6375.788	15680.00	9.91*		4p	4P5/2	-	7d 4F7/2
11		6375.681	15680.26	(.26)		4p	4D7/2	-	6d 4F9/2
7		6369.130	15696.39	.39		4p	4D1/2	-	6d 4F3/2
00		6364.144	15708.69	.68		4p	2D3/2	-	9s 4P3/2
1		6362.983	15711.56	.57		4p	4D5/2	-(1D2)	5s 2D5/2
0		6360.513	15717.66	.68		4p	4D5/2	-(1D2)	5s 2D3/2
0	d	6354.272	15733.09	.04*		4p	2D5/2	-	8d 4F7/2
00		6351.524	15739.90	.85*		sp44	P3/2	-(1D2)	4p 2P1/2
7		6348.712	15746.87	.86		4p	4D7/2	-	6d 4D7/2
1	d	6346.591	15752.14	.09*		4p	4P3/2	-	7d 4F5/2
4		6320.395	15817.42	.43		4p	4D5/2	-	6d 4D5/2
2		6319.780	15818.96	.96		sp44	P5/2	-	5p 4D3/2
1		6316.518	15827.13	.14		4p	4D3/2	-	6d 2P3/2
1	d	6315.109	15830.66	.62*		4p	4D5/2	-	6d 4D3/2
				.66		4p	4S3/2	-	7d 4P3/2
0		6313.900	15833.69	.72		4p	4D3/2	-	6d 4D1/2
1		6306.337	15852.68	.69		4p	4D3/2	-(1D2)	5s 2D3/2
00		6299.896	15868.89	.91		sp44	P1/2	-	5p 4P3/2
2		6295.708	15879.45	.46		sp44	P1/2	-	5p 4P1/2
1		6291.094	15891.09	.08		4p	4P3/2	-	7d 2P3/2
	m	6285.	15904.	.21*		4p	4S3/2	-	7d 4P1/2
0		6283.497	15910.31	.28		4p	4D1/2	-	6d 4D1/2
0		6274.745	15932.50	.51		4p	4D7/2	-	6d 4P5/2
00		6272.967	15937.01	.07*		4p	4D5/2	-	6d 2F5/2
2		6268.183	15949.18	.19		4p	4D5/2	-	6d 4D7/2
1		6267.901	15949.89	.91		sp44	P5/2	-	5p 4D5/2
0		6266.872	15952.51	.44*		4p	4D3/2	-	6d 4D5/2
1	bl	6266.166	15954.31	.36*		sp44	P5/2	-(1D2)	4p 2P3/2
1		6261.732	15965.61	.63		4p	4D3/2	-	6d 4D3/2
3		6259.760	15970.64	.63		4p	4P5/2	-	7d 4D7/2
2	w	6258.705	15973.33	.36		sp44	P3/2	-	5p 4P3/2
00		6256.996	15977.69	.70		4p	4P5/2	-	9s 4P3/2
1		6255.756	15980.86	.87		4p	2S1/2	-	7s 4P1/2

3		6254.566	15983.90	.91		sp44P3/2	-	5p 4P1/2
1		6253.764	15985.95	.95		4p 4S3/2	-	9s 4P5/2
				.94		4p 4P3/2	-	7d 4D5/2
1		6230.362	16045.99	.98		4p 4P5/2	-	7d 4P5/2
1		6224.992	16059.83	.81		4p 2S1/2	-	5d 2D3/2
00		6220.272	16072.02	.08*		4p 4D3/2	-	6d 2F5/2
1		6215.688	16083.89	.89		4p 2D5/2	-	8d 2F7/2
12		6210.499	16097.31	.33		4s 2P3/2	-(1D2)	4p 2D3/2
15		6199.024	16127.11	.11		4s 2P3/2	-(1D2)	4p 2D5/2
00		6198.494	16128.49	.51		4p 4D3/2	-	8s 4P1/2
2		6196.735	16133.07	.06		4p 2S1/2	-	7s 2P1/2
1		6196.221	16134.41	.41		4p 4D5/2	-	8s 4P3/2
0	aff	6196.071	16134.80	.84*		4p 4D5/2	-	6d 4P5/2
00		6195.550	16136.15	.16		4p 2D3/2	-	8d 2F5/2
00		6192.853	16143.18	.18		4p 4D1/2	-	6d 2P1/2
7	w	6188.420	16154.74	.73		sp44P5/2	-	5p 4P3/2
4		6175.256	16189.18	.19		sp44P3/2	-	5p 4P5/2
4		6170.664	16201.23	.23		sp44P1/2	-	5p 4S3/2
0		6167.321	16210.01	9.98		4p 4D5/2	-	6d 2F7/2
2		6160.660	16227.54	.53		4p 4D7/2	-	8s 4P5/2
0		6159.753	16229.93	.94		4p 4P3/2	-	7d 4P5/2
1		6144.800	16269.42	.41		4p 4D3/2	-	8s 4P3/2
7		6131.135	16305.68	.68		sp44P3/2	-	5p 4S3/2
00		6127.800	16314.56	.56		4p 4D3/2	-	6d 2D3/2
6		6106.834	16370.57	.56		sp44P5/2	-	5p 4P5/2
0	d	6099.158	16391.17	.13*		4p 4D1/2	-	6d 2D3/2
12		6097.690	16395.11	.13		4s 2P1/2	-(1D2)	4p 2D3/2
0	d	6090.056	16415.67	.61*		4p 2S1/2	-(1D2)	3d 2S1/2
0	d	6084.807	16429.83	.85		4p 4D5/2	-	8s 4P5/2
1		6083.550	16433.22	.22		4p 2S1/2	-(1D2)	3d 2P1/2
00		6081.040	16440.00	9.95		4p 4D3/2	-	6d 2D5/2
00		6070.976	16467.26	.18*		4p 4D1/2	-	6d 4P3/2
0	d	6065.900	16481.04	.04		4p 2D5/2	-	9d 2F7/2
6		6063.676	16487.08	.05		sp44P5/2	-	5p 4S3/2
1	aff	6056.270	16507.24	.10*	(1D2)	4s 2D5/2	-(3P1)	6f (3)7/2
4	aff	6043.090	16543.25	.26*		4s 2P3/2	-(1D2)	4p 2F5/2
3	w	6033.110	16570.61	.54*		4p 2S1/2	-	7s 2P3/2
00		6028.687	16582.77	.76		4p 4P3/2	-	8d 4D5/2
1		6025.156	16592.49	(.49)		4p 4P5/2	-	8d 4D7/2
0		6014.132	16622.90	.90		4p 4P5/2	-	8d 4P5/2
0		6013.100	16625.75	.77		4p 4D3/2	-	7d 4F3/2
3		6008.296	16639.05	.02		4p 4D5/2	-	7d 4F7/2
3		5999.922	16662.27	.25		4p 4D3/2	-	7d 4F5/2
0	d	5989.635	16690.89	.88		4p 4D1/2	-	8s 2P3/2
4		5989.376	16691.61	(.61)		4p 4D7/2	-	7d 4F9/2
1		5985.520	16702.36	.34		4p 4D1/2	-	7d 4F3/2
1		5976.552	16727.42	.42		4p 4D7/2	-	7d 4D7/2
0	d	5964.522	16761.16	.10*		4p 4D5/2	-	7d 4D5/2
00		5942.872	16822.22	.22		4p 4D1/2	-(1D2)	3d 2D3/2
7		5905.012	16930.07	.06		4s 2P3/2	-	5p 2S1/2
0		5876.920	17011.00	(.00)		4p 4P5/2	-	9d 4D7/2

1	aff	5867.669	17037.82	.67*	4p 2S1/2 - 6d 2P3/2
00		5855.984	17071.82	.82	4p 4D3/2 - 9s 4P3/2
1		5840.560	17116.90	.89	4s 2P3/2 - 5p 4D1/2
6		5802.941	17227.86	.85	4s 2P1/2 - 5p 2S1/2
2		5791.539	17261.78	.78	4p 4D5/2 - 8d 4F7/2
2		5786.390	17277.14	.14	4p 2S1/2 - 6d 2P1/2
3		5784.958	17281.42	.41	4s 2P3/2 -(1D2)4p 2P1/2
1		5784.006	17284.26	(.26)	4p 4D3/2 - 8d 4F5/2
00		5782.520	17288.70	.73	4p 4D3/2 - 7d 4P1/2
4		5775.375	17310.09	.09	4s 2P3/2 - 5p 4D5/2
3		5773.893	17314.54	.54	4s 2P3/2 -(1D2)4p 2P3/2
0		5773.328	17316.23	.24	4p 4D1/2 - 8d 4F3/2
2		5769.258	17328.45	(.45)	4p 4D7/2 - 8d 4F9/2
00		5757.010	17365.31	.30	4p 4D1/2 - 7d 4P1/2
0		5740.690	17414.68	.68	4s 2P1/2 - 5p 4D1/2
1		5720.234	17476.95	.94	4s 2P1/2 - 5p 4D3/2
2		5707.828	17514.94	.92	4s 2P3/2 - 5p 4P3/2
1		5704.401	17525.46	.47	4s 2P3/2 - 5p 4P1/2
0		5679.866	17601.17	.14	4p 2S1/2 - 6d 4P3/2
1		5676.255	17612.36	.33	4s 2P1/2 -(1D2)4p 2P3/2
00	d	5662.010	17656.67	.74*	4p 2S1/2 - 6d 4P1/2
0		5654.451	17680.28	.28	4p 4D5/2 - 9d 4F7/2
1		5638.355	17730.75	.75	4s 2P3/2 - 5p 4P5/2
0	w	5630.611	17755.13	(.13)	4p 4D7/2 - 9d 4F9/2
2		5608.587	17824.85	.84	4p 2S1/2 - 8s 2P3/2
7		5573.001	17938.67	.64	sp44P3/2 -(3P0)4f (3)5/2
2		5567.568	17956.18	.18	4p 2S1/2 -(1D2)3d 2D3/2
0	d	5550.361	18011.84	.77*	4p 2S1/2 - 7d 2P3/2
7		5548.515	18017.84	.83	4s 2P3/2 - 5p 2D3/2
8		5546.943	18022.94	.95	sp44P1/2 -(3P1)4f (2)3/2
7		5533.135	18067.92	.92	sp44P3/2 -(3P1)4f (3)5/2
5	aff	5517.217	18120.05	.01*	sp44P5/2 -(3P0)4f (3)5/2
10		5516.997	18120.77	.77	sp44P5/2 -(3P0)4f (3)7/2
7	aff	5514.957	18127.47	.40*	sp44P3/2 -(3P1)4f (2)3/2
10		5514.774	18128.07	.06	sp44P3/2 -(3P1)4f (2)5/2
0		5509.617	18145.04	.03	4s 2P1/2 - 5p 4S3/2
1		5489.706	18210.85	.85	4s 4P3/2 -(1D2)4p 2D5/2
11		5478.267	18248.88	.90*	sp44P1/2 -(3P2)4f (1)1/2
				.74*	sp44P1/2 -(3P2)4f (1)3/2
11	aff	5477.860	18250.23	.19*	sp44P5/2 -(3P1)4f (3)7/2
12		5477.672	18250.86	.86	4s 2P3/2 - 5p 2D5/2
2		5460.338	18308.80	.77	sp44P5/2 -(3P1)4f (2)3/2
7		5460.141	18309.46	.43	sp44P5/2 -(3P1)4f (2)5/2
6		5459.292	18312.30	.30	sp44P1/2 -(3P2)4f (2)3/2
11		5458.305	18315.62	.63	4s 2P1/2 - 5p 2D3/2
9		5447.114	18353.25	.35*	sp44P3/2 -(3P2)4f (1)1/2
				.19*	sp44P3/2 -(3P2)4f (1)3/2
7		5428.324	18416.77	.75	sp44P3/2 -(3P2)4f (2)3/2
10		5428.094	18417.55	.56	sp44P3/2 -(3P2)4f (2)5/2
5		5417.267	18454.30	.36	sp44P3/2 -(3P2)4f (3)5/2
4		5393.820	18534.56	.56	sp44P5/2 -(3P2)4f (1)3/2
3		5373.340	18587.93	.91	4p 2P3/2 - 5p 2P1/2

1		5375.382	18598.16	.12	sp44P5/2	-(3P2)4f	(2)3/2		
9	bl	5375.140	18599.00	.93*	sp44P5/2	-(3P2)4f	(2)5/2		
0		5373.818	18603.57	.57	4p 2S1/2	-	9s	2P3/2	
10		5364.631	18635.43	.42	sp44P5/2	-(3P2)4f	(3)7/2		
3	d	5361.849	18645.10	.14*	sp44P5/2	-(3P2)4f	(4)7/2		
12		5345.851	18700.90	.88	4s 2P3/2	-	5p	2P3/2	
11		5293.539	18885.70	.70	4s 2P1/2	-	5p	2P1/2	
7		5262.057	18998.69	.68	4s 2P1/2	-	5p	2P3/2	
1		5257.866	19013.83	.80*	4s 4P3/2	-	5p	2S1/2	
				.86*	4s 4P5/2	-	5p	4D3/2	
0		5216.393	19165.00	5.00	4s 4P1/2	-	5p	2S1/2	
1		5206.712	19200.63	.63	4s 4P3/2	-	5p	4D1/2	
9		5189.890	19414.08	.09	4s 4P1/2	-	5p	4D3/2	
0		5166.620	19349.62	.63	4s 4P5/2	-	5p	4P3/2	
8		5166.031	19351.83	.84	4s 4P1/2	-	5p	4D1/2	
12	bl	5162.290	19365.85	.95	4s 4P5/2	-	5p	4D7/2	
11		5154.844	19393.83	.83	4s 4P3/2	-	5p	4D3/2	
5		5153.658	19398.29	.28	4s 4P3/2	-(1D2)4p	2P3/2		
9		5149.465	19414.08	.09	4s 4P1/2	-	5p	4D3/2	
00	d	5132.869	19476.85	.86	sp44P1/2	-	6p	4P3/2	
4		5131.990	19480.19	.19	4s 2P3/2	-(3P0)4f	(3)5/2		
0		5123.067	19514.12	.05*	sp44P3/2	-	6p	4D5/2	
4		5122.481	19516.35	.35	4s 4P1/2	-(1D2)4p	2P1/2		
9		5113.798	19549.49	.48	4s 4P1/2	-(1D2)4p	2P3/2		
11		5109.628	19565.44	.46*	4s 4P5/2	-	5p	4P5/2	
	m			.57*	sp44P5/2	-	6p	4D3/2	
0		5105.493	19581.29	.31	sp44P3/2	-	6p	4P3/2	
10		5100.974	19598.64	.66	4s 4P3/2	-	5p	4P3/2	
10		5098.221	19609.22	.21	4s 4P3/2	-	5p	4P1/2	
00		5082.710	19669.06	8.95*	4s 2P3/2	-(3P1)4f	(2)3/2		
2		5082.570	19669.60	.62	4s 2P3/2	-(3P1)4f	(2)5/2		
10		5079.381	19681.95	.95	4s 4P5/2	-	5p	4S3/2	
0		5075.904	19695.43	.42	sp44P5/2	-	6p	4D5/2	
3	aff	5061.882	19749.99	.86*	4s 4P1/2	-	5p	4P3/2	
4		5059.212	19760.42	.41	4s 4P1/2	-	5p	4P1/2	
4		5058.635	19762.67	.68	sp44P5/2	-	6p	4P3/2	
8		5045.409	19814.47	.49	4s 4P3/2	-	5p	4P5/2	
1		5037.384	19846.04	.07	sp44P3/2	-	6p	4P5/2	
1		5025.044	19894.77	.91*	4s 2P3/2	-(3P2)4f	(1)1/2		
				.74*	4s 2P3/2	-(3P2)4f	(1)3/2		
3		5022.337	19905.50	.50	sp44P3/2	-	6p	4S3/2	
6	bl	5015.870	19931.16	.98*	4s 4P3/2	-	5p	4S3/2	
1		5008.849	19959.10	.11	4s 2P3/2	-(3P2)4f	(2)5/2		
2		5006.929	19966.75	.74	4s 2P1/2	-(3P1)4f	(2)3/2		
3		4999.624	19995.93	.92	4s 2P3/2	-(3P2)4f	(3)5/2		
1		4991.758	20027.44	.44	sp44P5/2	-	6p	4P5/2	
4		4978.151	20082.18	.18	4s 4P1/2	-	5p	4S3/2	
2		4977.312	20085.56	.57	4s 4P5/2	-	5p	2D5/2	
2		4976.984	20086.89	.88	sp44P5/2	-	6p	4S3/2	
0		4954.784	20176.88	.86	sp44P5/2	-	6p	2D5/2	
4		4950.948	20192.52	.70*	4s 2P1/2	-(3P2)4f	(1)1/2		
				.54*	4s 2P1/2	-(3P2)4f	(1)3/2		

1	aff	4935.441	20255.96	6.10*	4s 2P1/2	-(3P2)4f (2)3/2
2		4891.395	20438.36	.38	sp44P3/2	-(3P0)5f (3)5/2
3		4873.415	20513.76	.79	sp44P1/2	-(3P1)5f (2)3/2
3		4856.820	20583.85	.86	sp44P3/2	-(3P1)5f (3)5/2
2		4848.709	20618.29	.24	sp44P3/2	-(3P1)5f (2)3/2
4		4848.553	20618.95	.93	sp44P3/2	-(3P1)5f (2)5/2
6		4848.220	20620.37	.34	sp44P5/2	-(3P0)5f (3)7/2
9		4814.246	20765.88	.90	sp44P5/2	-(3P1)5f (3)7/2
5		4812.405	20773.82	.83	sp44P1/2	-(3P2)5f (1)1/2
3		4790.288	20869.74	.72	4s 2P3/2	- 6p 2S1/2
6		4788.328	20878.28	.27*	sp44P3/2	-(3P2)5f (1)1/2
				.26*	sp44P3/2	-(3P2)5f (1)3/2
1		4781.974	20906.02	.01	sp44P3/2	-(3P2)5f (2)3/2
5		4781.865	20906.50	.52	sp44P3/2	-(3P2)5f (2)5/2
1		4777.130	20927.22	.23	sp44P3/2	-(3P2)5f (3)5/2
1		4775.161	20935.85	.83	4s 4P1/2	- 5p 2P3/2
0		4748.008	21055.57	.60	4s 2P3/2	- 6p 4D5/2
0		4747.093	21059.63	.63	sp44P5/2	-(3P2)5f (1)3/2
3		4740.729	21087.90	.90	sp44P5/2	-(3P2)5f (2)5/2
3		4736.138	21108.35	.37	sp44P5/2	-(3P2)5f (3)7/2
0		4734.901	21113.86	.85	sp44P5/2	-(3P2)5f (4)7/2
0		4732.876	21122.89	.86	4s 2P3/2	- 6p 4P3/2
1		4722.905	21167.49	.51	4s 2P1/2	- 6p 2S1/2
0		4710.438	21223.51	.54	4s 2P1/2	- 6p 4D3/2
0	bl	4646.451	21515.78	.68*	4s 2P3/2	- 6p 2P1/2
5		4641.860	21537.06	.04	4s 2P3/2	- 6p 2D5/2
3		4641.489	21538.78	.80	4s 2P1/2	- 6p 2D3/2
4		4616.387	21655.90	.91	4s 2P3/2	- 6p 2P3/2
2		4583.036	21813.49	.47	4s 2P1/2	- 6p 2P1/2
0		4577.446	21840.12	.03*	4s 4P5/2	-(3P2)4f (4)7/2
00		4572.407	21864.19	.16	sp44P1/2	-(3P1)6f (2)3/2
0		4553.767	21953.69	.70	4s 2P1/2	- 6p 2P3/2
00		4550.688	21968.54	.61*	sp44P3/2	-(3P1)6f (2)3/2
0		4550.562	21969.15	.15	sp44P3/2	-(3P1)6f (2)5/2
1		4549.081	21976.30	.29	sp44P5/2	-(3P0)6f (3)7/2
1		4548.330	21979.93	.94	4s 2P3/2	-(3P0)5f (3)5/2
3		4517.558	22129.65	.69*	4s 4P1/2	-(3P2)4f (1)3/2
				.85*	4s 4P1/2	-(3P2)4f (1)1/2
				.68*	sp44P5/2	-(3P1)6f (3)7/2
0		4515.283	22140.80	.79	sp44P1/2	-(3P2)6f (1)3/2
0		4513.305	22150.50	.52	sp44P5/2	-(3P1)6f (2)5/2
0		4512.106	22156.39	.39	sp44P1/2	-(3P2)6f (2)3/2
0		4511.267	22160.51	.49	4s 2P3/2	-(3P1)5f (2)5/2
1		4494.083	22245.24	.24	sp44P3/2	-(3P2)6f (1)
1		4490.852	22261.24	.27	sp44P3/2	-(3P2)6f (2)5/2
0		4488.363	22273.59	.56	sp44P3/2	-(3P2)6f (3)5/2
0		4454.540	22442.71	.64	sp44P5/2	-(3P2)6f (2)5/2
00		4453.464	22448.13	.08*	4s 2P3/2	-(3P2)5f (2)5/2
1		4452.150	22454.76	.76	sp44P5/2	-(3P2)6f (3)7/2
0		4451.582	22457.62	.59	4s 2P1/2	-(3P1)5f (2)3/2
0		4449.381	22468.73	.79	4s 2P3/2	-(3P2)5f (3)5/2

0		4408.304	22678.09	(.09)	sp44P1/2	-(3P1)7f (2)3/2
0		4400.636	22717.61	.61*	4s 2P1/2	-(3P2)5f (1)3/2
				.62*	4s 2P1/2	-(3P2)5f (1)1/2
0		4395.262	22745.38	.36	4s 2P1/2	-(3P2)5f (2)3/2
00	d	4390.703	22769.00	9.05	sp44P3/2	-(3P1)7f (3)5/2
	m	4388.	22782.	.49*	sp44P3/2	-(3P1)7f (2)5/2
0		4386.098	22792.91	.85	sp44P5/2	-(3P0)7f (3)7/2
00		4367.432	22890.32	.32	4s 4P5/2	- 6p 4D5/2
1		4355.997	22950.41	.40	sp44P5/2	-(3P1)7f (3)7/2
00		4354.632	22957.60	.57	4s 4P5/2	- 6p 4P3/2
1		4353.670	22962.67	.67	sp44P1/2	-(3P2)7f (1)
0		4353.429	22963.94	.86	sp44P5/2	-(3P1)7f (2)5/2
0		4344.810	23009.50	.49	4s 4P3/2	- 6p 4D3/2
00		4331.520	23080.09	9.93*	sp44P3/2	-(3P2)7f (2)5/2
1		4320.426	23139.36	.34	4s 4P3/2	- 6p 4D5/2
0		4319.334	23145.21	.18	4s 4P5/2	- 6p 4D7/2
2		4316.443	23160.71	.69	4s 4P1/2	- 6p 4D3/2
00	d	4310.967	23190.13	.22*	4s 4P1/2	- 6p 4D1/2
3		4307.909	23206.59	.60	4s 4P3/2	- 6p 4P3/2
3		4304.981	23222.37	.33	4s 4P5/2	- 6p 4P5/2
0		4296.870	23266.21	(.21)	sp44P5/2	-(3P2)7f (3)7/2
5		4294.001	23281.75	.77	4s 4P5/2	- 6p 4S3/2
0		4286.075	23324.81	.75	4s 4P3/2	- 6p 2D3/2
2		4280.018	23357.81	.81	4s 4P1/2	- 6p 4P3/2
0		4258.473	23475.99	.96	4s 4P1/2	- 6p 2D3/2
1		4248.550	23530.82	.80	4s 4P3/2	- 6p 4S3/2
0		4232.392	23620.65	.78*	4s 4P3/2	- 6p 2D5/2
00		4221.390	23682.21	.00*	4s 4P1/2	- 6p 4S3/2
0		4060.394	24621.20	.10*	4s 2P3/2	-(3P2)7f (2)3/2

Comments

λ(Å)		
10239.91	blended by a line of unknown origin	
10049.37	blended by H I	10049.38 Å
10039.86	blended by a line of unknown origin	
9369.69	blended by a line of unknown origin	
9223.	masked by P II	9223.940 Å
8537.489	blended probably	
8266.935	affected by Ne I	8266.079 Å
8227.584	blended by P I	6170.672 Å (other order)
8046.076	affected by P II	6043.086 Å (other order)
7282.410	affected by He I	7281.349 Å
7281.	masked by He I	7281.349 Å
7257.	blended by P II	7257.363 Å
7245.	masked by Ne I	7245.167 Å
7107.731	blended by Ne I	5330.778 Å (other order)
7069.600	blended by He I	7067.707 Å
7024.339	blended by Ne I	7024.050 Å
6812.868	blended by P I	5109.628 Å (other order)
6736.203	blended by a PH molecular line	
6716.196	affected by Ne I	6717.0428 Å
6713.	masked by P II	6713.279 Å
6684.	masked by Ar II	6684.291 Å
6508.725	affected by P II	6507.977 Å
6499.118	affected by P II	6503.400 Å
6375.788	blended by P II	6375.681 Å
6285.	masked by P II	6285.922 Å
6266.166	blended by Ne I	6266.495 Å
6056.270	affected by P II	6055.503 Å
6043.090	affected by P II	6043.086 Å
6033.110	affected by P II	6033.110 Å
5867.669	affected by He I	5875.995 Å
5514.959	affected by P I	5514.774 Å
5375.140	blended by Ar II	4300.101 Å (other order)
5162.290	blended by Ar I	5162.285 Å

5109.	masked by P I	5109.628 Å
5061.882	affected by Ar I	5061.037 Å
5015.870	blended by He I	5015.678 Å
4935.441	affected by P II	4935.632 Å
4646.451	blended by Ar II	3717.171 Å (other order)
4388.	masked by He I	4387.929 Å

TABLE III. P I lines in the region 2700 - 1200 Å.

Abbreviations: aff = affected; bl = blended; d = diffuse; m=masked; w=wide.
MZ; the wavelength is taken from the list of Magnusson and Zetterberg.
See also comments at the end of the table.

Starred lines (*) were not used in the least squares fit.

Intensity and shape		λ_{air}(Å)	σ(cm^{-1}) Obs.	Calc.	Transition
5	MZ	2688.000	37191.34	.41	3p 2P3/2 - 4s 4P1/2
3	MZ	2686.183	37216.49	.71	3p 2P1/2 - 4s 4P1/2
8	MZ	2677.113	37342.58	.62	3p 2P3/2 - 4s 4P3/2
5	MZ	2675.301	37367.87	.92	3p 2P1/2 - 4s 4P3/2
15	MZ	2554.915	39128.51	.56	3p 2P3/2 - 4s 2P1/2
17	MZ	2553.262	39153.84	.87	3p 2P1/2 - 4s 2P1/2
18	MZ	2535.603	39426.50	.36	3p 2P3/2 - 4s 2P3/2
17	MZ	2533.976	39451.83	.66	3p 2P1/2 - 4s 2P3/2
4		2451.050	40786.49	.54	3p 2P3/2 - sp44P5/2
00	aff	2438.643	40993.99	.22*	3p 2P1/2 - sp44P3/2
00		2434.007	41072.06	.36	3p 2P3/2 - sp44P1/2
00	aff	2432.531	41096.98	7.67*	3p 2P1/2 - sp44P1/2
9		2242.539	44578.48	.40	3p 2D3/2 - 4s 4P1/2
12		2235.732	44714.20	.00	3p 2D5/2 - 4s 4P3/2
8		2234.958	44729.68	.60	3p 2D3/2 - 4s 4P3/2
9		2223.359	44963.00	3.03	3p 2D5/2 - 4s 4P5/2
4		2222.577	44978.81	.63	3p 2D3/2 - 4s 4P5/2
15		2154.080	46408.94	.23*	3p 2P3/2 -(D)4s 2D3/2
				9.12*	3p 2P3/2 -(D)4s 2D5/2
13	MZ	2152.940	46433.51	.54	3p 2P1/2 -(D)4s 2D3/2
14		2149.145	46515.50	.55	3p 2D3/2 - 4s 2P1/2
14		2136.182	46797.73	.74	3p 2D5/2 - 4s 2P3/2
14		2135.465	46813.43	.34	3p 2D3/2 - 4s 2P3/2
3		2075.850	48157.68	.92	3p 2D5/2 - sp44P5/2
2	aff	2075.106	48174.94	3.53*	3p 2D3/2 - sp44P5/2
3		2068.050	48339.30	.30	3p 2D5/2 - sp44P3/2
2		2067.391	48354.71	.90	3p 2D3/2 - sp44P3/2
1		2062.923	48459.43	.35	3p 2D3/2 - sp44P1/2
14	MZ	2033.477	49161.04	.13	3p 2P3/2 - 3d 2P3/2
14	MZ	2032.432	49186.31	.43	3p 2P1/2 - 3d 2P3/2
12	MZ	2024.516	49378.62	.60	3p 2P3/2 - 3d 2P1/2
13		2023.489	49403.67	.90	3p 2P1/2 - 3d 2P1/2
5		2022.209	49434.93	5.18	3p 2P3/2 - 3d 4F3/2
2	MZ	2021.172	49460.29	.48	3p 2P1/2 - 3d 4F3/2

Intensity and shape	λ_{vac}(Å)	σ(cm^{-1}) Obs.	Calc.	Transition
4	1955.800	51129.97	30.02	3p 2P3/2 - 3d 4D1/2
4	1955.170	51146.45	.30	3p 2P3/2 - 3d 4D3/2
5	1954.829	51155.37	.33	3p 3P1/2 - 3d 4D1/2
3	1954.208	51171.62	.60	3p 2P1/2 - 3d 4D3/2
3	1954.026	51176.40	.44	3p 2P3/2 - 3d 4D5/2
3	1936.347	51643.64	.79	3p 2P3/2 - 3d 2F5/2

3		1907.665	52420.10	.22	3p	2P3/2	- sp42D5/2
1		1906.403	52454.81	.97	3p	2P3/2	- sp42D3/2
2	MZ	1905.481	52480.19	.27	3p	2P1/2	- sp42D3/2
2		1864.628	53630.00	9.99	3p	2P3/2	- 5s 4P1/2
1		1864.348	53638.06	.34	3p	2P3/2	- 3d 4P5/2
4		1863.741	53655.52	.29	3p	2P1/2	- 5s 4P1/2
6		1860.612	53745.76	.80	3p	2P3/2	- 3d 4P3/2
4		1859.736	53771.07	.10	3p	2P1/2	- 3d 4P3/2
4		1859.393	53780.99	9.62*	3p	2D5/2	-(D)4s 2D3/2
				.50*	3p	2D5/2	-(D)4s 2D5/2
5		1858.886	53795.66	6.10*	3p	2D3/2	-(D)4s 2D5/2
				.22*	3p	2D3/2	-(D)4s 2D3/2
2		1857.907	53824.01	.39	3p	2P3/2	- 5s 4P3/2
6		1857.014	53849.89	.69	3p	2P1/2	- 5s 4P3/2
1		1856.334	53869.62	.78	3p	2P3/2	- 3d 4P1/2
2		1855.466	53894.82	5.08	3p	2P1/2	- 3d 4P1/2
0		1852.069	53993.67	.80	3p	2P3/2	- 3d 2D3/2
1		1851.194	54019.19	.10	3p	2P1/2	- 3d 2D3/2
0		1849.820	54059.31	.19	3p	2P3/2	- 5s 4P5/2
1		1847.165	54137.02	6.86	3p	2P3/2	- 3d 2D5/2
7		1845.158	54195.90	.79	3p	2P3/2	- 5s 2P1/2
8		1844.296	54221.23	.10	3p	2P1/2	- 5s 2P1/2
1		1834.801	54501.82	.80	3p	2P3/2	- 5s 2P3/2
8		1833.950	54527.11	.10	3p	2P1/2	- 5s 2P3/2
4		1787.656	55939.18	.42	3p	4S3/2	- 4s 4P1/2
5		1782.838	56090.35	.63	3p	4S3/2	- 4s 4P3/2
6	MZ	1774.951	56339.58	.66	3p	4S3/2	- 4s 4P5/2
8		1768.902	56532.24	.51	3p	2D5/2	- 3d 2P3/2
8		1768.414	56547.85	8.11	3p	2D3/2	- 3d 2P3/2
6		1761.639	56765.33	.58	3p	2D3/2	- 3d 2P1/2
3		1760.361	56806.52	.56	3p	2D5/2	- 3d 4F3/2
5		1759.880	56822.07	.16	3p	2D3/2	- 3d 4F3/2
6		1757.913	56885.65	.53	3p	2D5/2	- 3d 4F5/2
6		1757.445	56900.80	1.13	3p	2D3/2	- 3d 4F5/2
3		1756.610	56927.83	8.08	3p	2P3/2	- 4d 2P3/2
3		1755.829	56953.16	.38	3p	2P1/2	- 4d 2P3/2
8		1754.369	57000.56	.85	3p	2D5/2	- 3d 4F7/2
00		1752.349	57066.26	5.71*	3p	2P3/2	- 4d 2P1/2
4	bl	1751.799	57084.18	5.17*	3p	2P3/2	- 4d 2F5/2
2		1751.591	57090.95	1.01	3p	2P1/2	- 4d 2P1/2
0		1748.202	57201.61	.46	3p	2P3/2	- 4d 4F3/2
2		1747.439	57226.60	.76	3p	2P1/2	- 4d 4F3/2
4		1745.265	57297.89	.98	3p	2P3/2	- 4d 4F5/2
1		1728.983	57837.47	.70	3p	2P3/2	- 4d 4D3/2
00		1728.803	57843.47	.78	3p	2P1/2	- 4d 4D1/2
2		1728.218	57863.07	.00	3p	2P1/2	- 4d 4D3/2
5		1727.808	57876.81	.57	3p	4S3/2	- 4s 2P1/2
2		1727.725	57879.60	.89	3p	2P3/2	- 4d 4D5/2
7		1719.271	58164.17	.24	3p	2P3/2	-(S)4s 2S1/2
8		1718.972	58174.30	.37	3p	4S3/2	- 4s 2P3/2
9		1718.523	58189.50	.54	3p	2P1/2	-(S)4s 2S1/2
2		1708.878	58517.93	.68*	3p	2D5/2	- 3d 4D3/2

			.01*	3p	2D3/2	-	3d 4D1/2
4		1708.434	58533.14	.28	3p	2D3/2	- 3d 4D3/2
2		1707.998	58548.09	7.83	3p	2D5/2	- 3d 4D5/2
10		1707.553	58563.34	.43	3p	2D3/2	- 3d 4D5/2
10		1706.376	58603.73	.45	3p	2D5/2	- 3d 4D7/2
6		1695.338	58985.30	.67	3p	2P3/2	- 4d 4P5/2
10		1694.486	59014.95	5.18	3p	2D5/2	- 3d 2F5/2
00		1694.296	59021.58	.49	3p	2P3/2	- 6s 4P1/2
10		1694.028	59030.90	.78	3p	2D3/2	- 3d 2F5/2
1		1693.579	59046.55	.79	3p	2P1/2	- 6s 4P1/2
4		1692.452	59085.86	.74	3p	2P3/2	- 4d 2D3/2
6		1691.734	59110.96	1.04	3p	2P1/2	- 4d 2D3/2
3		1690.888	59140.52	.80	3p	2P3/2	- 4d 4P3/2
4		1690.158	59166.08	.10	3p	2P1/2	- 4d 4P3/2
3	aff	1689.334	59194.92	.54*	3p	2P3/2	- 6s 4P3/2
6		1689.218	59198.99	.69*	3p	2P3/2	- 4d 2D5/2
3		1688.626	59219.76	.84	3p	2P1/2	- 6s 4P3/2
1		1687.965	59242.92	.81	3p	2P1/2	- 4d 4P1/2
8		1686.301	59301.41	.06	3p	2P3/2	- 6s 2P1/2
11		1685.976	59312.83	.88	3p	2D5/2	- 3d 2F7/2
3		1685.592	59326.34	.37	3p	2P1/2	- 6s 2P1/2
0	d	1681.703	59463.53	.33	3p	2P3/2	- 6s 4P5/2
16		1679.695	59534.61	.55	3p	4S3/2	- sp44P5/2
5		1678.087	59591.65	.83	3p	2P3/2	-(D)3d 2F5/2
3		1677.553	59610.65	.79	3p	2P3/2	- 6s 2P3/2
2		1676.843	59635.89	6.09	3p	2P1/2	- 6s 2P3/2
16		1674.591	59716.07	5.92	3p	4S3/2	- sp44P3/2
11		1672.474	59791.67	.60	3p	2D5/2	- sp42D5/2
11		1672.035	59807.35	.21	3p	2D3/2	- sp42D5/2
12		1671.680	59820.04	.37	3p	4S3/2	- sp44P1/2
10		1671.510	59826.14	.36	3p	2D5/2	- sp42D3/2
11		1671.070	59841.88	.96	3p	2D3/2	- sp42D3/2
3		1656.333	60374.33	.18	3p	2P3/2	- 5d 2P3/2
1		1655.642	60399.53	.49	3p	2P1/2	- 5d 2P3/2
4		1653.663	60471.83	.55	3p	2P3/2	- 5d 2P1/2
4		1652.980	60496.81	.85	3p	2P1/2	- 5d 2P1/2
1		1650.393	60591.64	.37	3p	2P3/2	- 5d 4F3/2
2		1649.704	60616.93	.68	3p	2P1/2	- 5d 4F3/2
1		1648.689	60654.23	.09	3p	2P3/2	- 5d 4F5/2
2		1640.723	60948.76	.58	3p	2P3/2	- 5d 4D1/2
2		1640.135	60970.59	.48	3p	2P3/2	- 5d 4D3/2
2		1640.044	60973.97	.89	3p	2P1/2	- 5d 4D1/2
5		1639.075	61010.02	9.72	3p	2D5/2	- 3d 4P5/2
2		1638.975	61013.74	.76	3p	2P3/2	- 5d 4D5/2
4		1638.884	61017.14	6.98	3p	2D3/2	- 5s 4P1/2
3		1638.657	61025.58	.32	3p	2D3/2	- 3d 4P5/2
5		1636.199	61117.26	.18	3p	2D5/2	- 3d 4P3/2
5		1635.777	61133.01	2.76	3p	2D3/2	- 3d 4P3/2
6		1634.093	61196.04	5.76	3p	2D5/2	- 5s 4P3/2
3		1633.677	61211.60	.38	3p	2D3/2	- 5s 4P3/2
2		1632.486	61257.02	0.77	3p	2D3/2	- 3d 4P1/2

6		1629.589	61365.17	.18	3p	2D5/2	-	3d 2D3/2
8		1629.165	61381.13	.78	3p	2D3/2	-	3d 2D3/2
4		1627.847	61430.85	.58	3p	2D5/2	-	5s 4P5/2
3		1627.738	61434.96	5.28	3p	2P3/2	-	5d 2F5/2
3		1627.435	61446.40	.18	3p	2D3/2	-	5s 4P5/2
00		1626.744	61472.49	.45	3p	2P3/2	-	7s 4P1/2
1		1626.065	61498.16	7.76	3p	2P1/2	-	7s 4P1/2
9		1625.786	61508.70	.24	3p	2D5/2	-	3d 2D5/2
7		1625.378	61524.15	3.84	3p	2D3/2	-	3d 2D5/2
3		1624.654	61551.56	.40	3p	2P3/2	-	5d 2D3/2
2		1624.420	61560.43	.40	3p	2P3/2	-	5d 4P5/2
3		1623.987	61576.86	.70	3p	2P1/2	-	5d 2D3/2
6		1623.819	61583.22	2.78	3p	2D3/2	-	5s 2P1/2
2		1622.719	61624.96	.64	3p	2P3/2	-	7s 2P1/2
2		1622.514	61632.74	.48	3p	2P3/2	-	7s 4P3/2
3		1622.058	61650.08	9.94	3p	2P1/2	-	7s 2P1/2
2		1621.848	61658.06	7.79	3p	2P1/2	-	7s 4P3/2
4		1621.320	61678.14	.26	3p	2P3/2	-	5d 4P3/2
1		1620.652	61703.56	.56	3p	2P1/2	-	5d 4P3/2
0	d	1619.162	61760.34	.14	3p	2P3/2	-	5d 4P1/2
5		1618.927	61769.31	.04	3p	2P3/2	-	5d 2D5/2
00		1618.497	61785.72	.44	3p	2P1/2	-	5d 4P1/2
5		1618.098	61800.95	.76	3p	2P3/2	-(D)3d	2P3/2
2		1617.434	61826.31	.07	3p	2P1/2	-(D)3d	2P3/2
7		1616.202	61873.44	.18	3p	2D5/2	-	5s 2P3/2
6		1615.803	61888.74	.78	3p	2D3/2	-	5s 2P3/2
2		1615.318	61907.29	.20	3p	2P3/2	-(D)3d	2S1/2
2		1614.853	61925.14	4.80	3p	2P3/2	-(D)3d	2P1/2
4		1614.658	61932.62	.50	3p	2P1/2	-(D)3d	2S1/2
4		1614.199	61950.25	.10	3p	2P1/2	-(D)3d	2P1/2
4		1611.281	62062.42	.12	3p	2P3/2	-	7s 2P3/2
2		1610.624	62087.75	.43	3p	2P1/2	-	7s 2P3/2
00		1604.576	62321.77	.93	3p	2P3/2	-	6d 4F3/2
2		1603.920	62347.24	.24	3p	2P1/2	-	6d 4F3/2
3		1599.246	62529.48	.26	3p	2P3/2	-	6d 2P3/2
0		1599.086	62535.72	.83	3p	2P3/2	-	6d 4D1/2
3		1598.750	62548.87	.69	3p	2P3/2	-(D)5s	2D5/2
1		1598.609	62554.38	.56*	3p	2P1/2	-	6d 2P3/2
				.80*	3p	2P3/2	-(D)5s	2D3/2
1		1598.428	62561.45	.13	3p	2P1/2	-	6d 4D1/2
3		1597.951	62580.16	.11	3p	2P1/2	-(D)5s	2D3/2
3		1596.051	62654.63	.55	3p	2P3/2	-	6d 4D5/2
1		1595.717	62667.75	.74	3p	2P3/2	-	6d 4D3/2
3		1595.070	62693.17	.05	3p	2P1/2	-	6d 4D3/2
0		1593.147	62768.86	.72	3p	2P3/2	-	6d 2P1/2
2		1593.002	62774.56	.19	3p	2P3/2	-	6d 2F5/2
1		1592.508	62794.04	.02	3p	2P1/2	-	6d 2P1/2
0		1591.567	62831.17	.63	3p	2P3/2	-	8s 4P1/2
1		1590.934	62856.14	5.93	3p	2P1/2	-	8s 4P1/2
2		1588.007	62972.04	1.96*	3p	2P3/2	-	6d 4P5/2
				1.53*	3p	2P3/2	-	8s 4P3/2
0		1587.384	62996.72	.83	3p	2P1/2	-	8s 4P3/2

3		1586.878	63016.81	.67	3p	2P3/2	-	6d 2D3/2
0		1586.717	63023.20	.27	3p	2P3/2	-	8s 2P1/2
3		1586.240	63042.16	1.97	3p	2P1/2	-	6d 2D3/2
1		1586.078	63048.59	.57	3p	2P1/2	-	8s 2P1/2
0		1584.964	63092.92	.72	3p	2P3/2	-	6d 4P3/2
00		1584.329	63118.20	.03	3p	2P1/2	-	6d 4P3/2
4		1583.727	63142.21	.07	3p	2P3/2	-	6d 2D5/2
00		1583.537	63149.77	8.32*	3p	2P3/2	-	6d 4P1/2
2		1579.371	63316.36	.42	3p	2P3/2	-	8s 2P3/2
00		1579.087	63327.71	.88	3p	2P3/2	-	7d 4F3/2
1		1578.732	63341.95	.72	3p	2P1/2	-	8s 2P3/2
2		1578.460	63352.89	3.19	3p	2P1/2	-	7d 4F3/2
00		1578.181	63364.10	.36	3p	2P3/2	-	7d 4F5/2
00		1576.091	63448.10	7.76	3p	2P3/2	-(D)	3d 2D3/2
3		1575.466	63473.28	.07	3p	2P1/2	-(D)	3d 2D3/2
3		1575.166	63485.36	.04	3p	2P3/2	-(D)	3d 2D5/2
1		1574.710	63503.76	.35	3p	2P3/2	-	7d 2P3/2
1		1574.090	63528.75	.66	3p	2P1/2	-	7d 2P3/2
00		1571.673	63626.47	.79	3p	2P3/2	-	7d 2F5/2
00		1567.414	63799.35	.24	3p	2P1/2	-	9s 4P3/2
00		1566.371	63841.83	2.21	3p	2P3/2	-	7d 4P5/2
00		1564.471	63919.37	7.30*	3p	2P3/2	-	7d 4P3/2
0		1563.293	63967.54	.09	3p	2P1/2	-	8d 4F3/2
00		1562.786	63988.29	6.38*	3p	2P3/2	-	8d 4F5/2
0		1562.383	64004.78	5.30*	3p	2P3/2	-	7d 2D5/2
00		1562.073	64017.51	6.15*	3p	2P1/2	-	7d 4P1/2
00	d	1560.171	64095.54	.15	3p	2P3/2	-	9s 2P3/2
00		1559.541	64121.43	.46*	3p	2P1/2	-	9s 2P3/2
00		1559.130	64138.33	9.07	3p	2P1/2	-	8d 2P3/2
0		1557.550	64203.40	1.42*	3p	2P3/2	-	8d 2F5/2
3	aff	1555.209	64300.04	9.47*	3p	2D5/2	-	4d 2P3/2
3		1554.842	64315.22	.07	3p	2D3/2	-	4d 2P3/2
3	aff	1551.538	64452.18	.69*	3p	2D3/2	-	4d 2P1/2
5		1551.427	64456.78	.55	3p	2D5/2	-	4d 2F5/2
6		1551.056	64472.22	.15	3p	2D3/2	-	4d 2F5/2
7		1548.458	64580.39	.24	3p	2D5/2	-	4d 2F7/2
1	bl	1548.245	64589.26	8.44*	3p	2D3/2	-	4d 4F3/2
4		1546.319	64669.72	.36	3p	2D5/2	-	4d 4F5/2
5		1545.946	64685.31	4.96	3p	2D3/2	-	4d 4F5/2
5		1543.287	64796.75	.73	3p	2D5/2	-	4d 4F7/2
5		1534.757	65156.89	7.13*	3p	4S3/2	-(D)	4s 2D5/2
5				.24*	3p	4S3/2	-(D)	4s 2D3/2
00	d	1533.487	65210.86	9.08*	3p	2D5/2	-	4d 4D3/2
1		1533.166	65224.51	.68	3p	2D3/2	-	4d 4D3/2
1	aff	1532.185	65266.27	.88*	3p	2D3/2	-	4d 4D5/2
4		1530.617	65333.11	2.80	3p	2D5/2	-	4d 4D7/2
3		1525.518	65551.53	.22	3p	2D3/2	-(S)	4s 2S1/2
4	bl	1506.984	66357.72	.05*	3p	2D5/2	-	4d 4P5/2
5		1506.650	66372.41	.66	3p	2D3/2	-	4d 4P5/2
2		1505.625	66408.77	.47	3p	2D3/2	-	6s 4P1/2
3	bl	1504.711	66457.94	.12*	3p	2D5/2	-	4d 2D3/2
6		1504.331	66472.52	.72	3p	2D3/2	-	4d 2D3/2

3	1503.475	66512.59	.18	3p 2D5/2 - 4d 4P3/2
3	1503.123	66528.17	7.78	3p 2D3/2 - 4d 4P3/2
3 aff	1502.241	66567.21	5.92*	3p 2D5/2 - 6s 4P3/2
6	1502.195	66569.23	.08*	3p 2D5/2 - 4d 2D5/2
3 aff	1501.902	66582.25	1.52*	3p 2D3/2 - 6s 4P3/2
6	1501.825	66585.65	.68*	3p 2D3/2 - 4d 2D5/2
1	1501.400	66604.51	.50	3p 2D3/2 - 4d 4P1/2
5	1499.525	66687.78	8.05	3p 2D3/2 - 6s 2P1/2
00	1496.233	66834.51	.71	3p 2D5/2 - 6s 4P5/2
1	1495.875	66850.50	.31	3p 2D3/2 - 6s 4P5/2
5	1493.363	66962.97	3.21	3p 2D5/2 -(D)3d 2F5/2
5	1493.008	66978.88	.82	3p 2D3/2 -(D)3d 2F5/2
6	1492.940	66981.93	2.17	3p 2D5/2 - 6s 2P3/2
4	1492.588	66997.72	.77	3p 2D3/2 - 6s 2P3/2
8	1491.359	67052.93	.69	3p 2D5/2 -(D)3d 2F7/2
7	1488.029	67202.98	3.34	3p 2D5/2 -(D)3d 2G7/2
4	1476.115	67745.41	.57	3p 2D5/2 - 5d 2P3/2
2	1475.774	67761.07	.17	3p 2D3/2 - 5d 2P3/2
4	1473.658	67858.34	.54	3p 2D3/2 - 5d 2P1/2
3	1472.559	67909.01	.14	3p 4S3/2 - 3d 2P3/2
0	1471.389	67962.98	.76	3p 2D5/2 - 5d 4F3/2
1	1470.037	68025.51	.48	3p 2D5/2 - 5d 4F5/2
4	1469.706	68040.79	1.08	3p 2D3/2 - 5d 4F5/2
1	1467.849	68126.89	.61	3p 4S3/2 - 3d 2P1/2
4	1467.587	68139.07	8.73	3p 2D5/2 - 5d 4F7/2
00	1466.650	68182.59	3.19	3p 4S3/2 - 3d 4F3/2
1	1464.939	68262.23	.15	3p 4S3/2 - 3d 4F5/2
1	1463.358	68335.98	.57	3p 2D3/2 - 5d 4D1/2
0	1463.240	68341.49	.86	3p 2D5/2 - 5d 4D3/2
00	1462.884	68358.12	7.46	3p 2D3/2 - 5d 4D3/2
00	1462.321	68384.44	5.14	3p 2D5/2 - 5d 4D5/2
1	1461.974	68400.69	.74	3p 2D3/2 - 5d 4D5/2
2	1460.126	68487.25	.09	3p 2D5/2 - 5d 4D7/2
4	1453.350	68806.53	.67	3p 2D5/2 - 5d 2F5/2
m	1453.	68825.	2.27*	3p 2D3/2 - 5d 2F5/2
3	1450.904	68922.52	.78	3p 2D5/2 - 5d 2D3/2
2	1450.704	68932.05	1.79	3p 2D5/2 - 5d 4P5/2
1	1450.577	68938.07	.38	3p 2D3/2 - 5d 2D3/2
4	1450.382	68947.38	.39	3p 2D3/2 - 5d 4P5/2
0	1449.034	69011.48	.63	3p 2D3/2 - 7s 2P1/2
00	1448.905	69017.64	9.47*	3p 2D3/2 - 7s 4P3/2
3	1448.239	69049.39	.65	3p 2D5/2 - 5d 4P3/2
0	1447.913	69064.92	5.25	3p 2D3/2 - 5d 4P3/2
6	1447.504	69084.45	.54	3p 2D5/2 - 5d 2F7/2
3	1446.331	69140.47	.43	3p 2D5/2 - 5d 2D5/2
00	1446.191	69147.16	.12	3p 2D3/2 - 5d 4P1/2
4	1446.010	69155.84	6.03	3p 2D3/2 - 5d 2D5/2
3	1445.676	69171.77	2.15	3p 2D5/2 -(D)3d 2P3/2
2	1445.344	69187.66	.75	3p 2D3/2 -(D)3d 2P3/2
3	1443.124	69294.10	.18	3p 2D3/2 -(D)3d 2S1/2
4	1442.764	69311.40	.78	3p 2D3/2 -(D)3d 2P1/2
4	1440.231	69433.31	.51	3p 2D5/2 - 7s 2P3/2

2	1439.908	69448.90	9.11	3p	2D3/2	-	7s	2P3/2
00	1434.856	69693.40	.32	3p	2D5/2	-	6d	4F3/2
00	1434.536	69708.93	.92	3p	2D3/2	-	6d	4F3/2
00	1433.757	69746.83	7.01	3p	2D5/2	-	6d	4F5/2
3	1433.434	69762.53	.61	3p	2D3/2	-	6d	4F5/2
3	1431.489	69857.32	.13	3p	2D5/2	-	6d	4F7/2
4	1431.055	69878.49	.03	3p	4S3/2	-	3d	4D1/2
6	1430.732	69894.32	.31	3p	4S3/2	-	3d	4D3/2
2	1430.602	69900.66	.64	3p	2D5/2	-	6d	2P3/2
3	1430.277	69916.53	.24	3p	2D3/2	-	6d	2P3/2
4	1430.135	69923.44	4.45*	3p	4S3/2	-	3d	4D5/2
7			2.82*	3p	2D3/2	-	6d	4D1/2
1	1429.891	69935.42	.68	3p	2D3/2	-(D)	5s	2D5/2
3	1429.770	69941.31	.79	3p	2D3/2	-(D)	5s	2D3/2
2	1428.045	70025.79	.94	3p	2D5/2	-	6d	4D5/2
3	1427.755	70040.05	1.54*	3p	2D3/2	-	6d	4D5/2
1			39.13*	3p	2D5/2	-	6d	4D3/2
2	1427.458	70054.61	.73	3p	2D3/2	-	6d	4D3/2
1	1425.381	70156.69	5.71*	3p	2D3/2	-	6d	2P1/2
			7.70*	3p	2D5/2	-	6d	4D7/2
3	1425.294	70160.96	1.18	3p	2D3/2	-	6d	2F5/2
1	1424.145	70217.54	.61	3p	2D3/2	-	8s	4P1/2
1	1421.594	70343.56	2.92*	3p	2D5/2	-	8s	4P3/2
			.34*	3p	2D5/2	-	6d	4P5/2
0	1421.280	70359.13	8.94*	3p	2D3/2	-	6d	4P5/2
			8.52*	3p	2D3/2	-	8s	4P3/2
1	1420.618	70391.89	.80	3p	4S3/2	-	3d	2F5/2
2	1420.379	70403.76	.66	3p	2D3/2	-	6d	2D3/2
1	1420.246	70410.33	.26	3p	2D3/2	-	8s	2P1/2
3	1420.090	70418.06	.49	3p	2D5/2	-	6d	2F7/2
00	1419.172	70463.62	4.11	3p	2D5/2	-	6d	4P3/2
2	1418.173	70513.27	.46	3p	2D5/2	-	6d	2D5/2
2	1417.862	70528.71	9.06	3p	2D3/2	-	6d	2D5/2
00	1417.726	70535.49	.31	3p	2D3/2	-	6d	4P1/2
1	1414.677	70687.50	.81	3p	2D5/2	-	8s	2P3/2
0	1414.445	70699.08	.27	3p	2D5/2	-	7d	4F3/2
00	1414.134	70714.67	.87	3p	2D3/2	-	7d	4F3/2
2	1413.406	70751.10	.35	3p	2D3/2	-	7d	4F5/2
2	1411.740	70834.57	.75	3p	2D3/2	-(D)	3d	2D3/2
2	1411.487	70847.28	.53	3p	2D5/2	-	7d	4F7/2
3	1411.309	70856.21	.42	3p	2D5/2	-(D)	3d	2D5/2
2	1410.940	70874.72	.74	3p	2D5/2	-	7d	2P3/2
2	1410.630	70890.30	.34	3p	2D3/2	-	7d	2P3/2
2	1409.060	70969.29	.60	3p	2D5/2	-	7d	4D5/2
1	1408.744	70985.23	.20	3p	2D3/2	-	7d	4D5/2
00	1408.461	70999.48	8.18*	3p	2D5/2	-	7d	2F5/2
2	1408.187	71013.29	.78	3p	2D3/2	-	7d	2F5/2
00	1405.569	71145.58	.32	3p	2D5/2	-	9s	4P3/2
00	1405.116	71168.50	.23	3p	4S3/2	-	sp4	2D5/2
00	1404.215	71214.17	3.60	3p	2D5/2	-	7d	4P5/2
00	1403.931	71228.57	9.20	3p	2D3/2	-	7d	4P5/2

2		1403.245	71263.40	.79	3p 2D5/2	-	7d 2F7/2
1	w	1401.043	71375.40	3.37*	3p 2D3/2	-	8d 4F5/2
				6.69*	3p 2D5/2	-	7d 2D5/2
0		1400.740	71390.81	2.29*	3p 2D3/2	-	7d 2D5/2
0		1399.189	71469.97	.29	3p 2D5/2	-	8d 4F7/2
0		1398.950	71482.17	.14	3p 2D3/2	-	9s 2P3/2
0		1398.881	71485.71	.15	3p 2D5/2	-	8d 2P3/2
00		1398.563	71501.96	.75*	3p 2D3/2	-	8d 2P3/2
00		1397.301	71566.54	.41	3p 2D5/2	-	8d 4D5/2
0		1397.008	71581.53	2.01	3p 2D3/2	-	8d 4D5/2
0		1396.863	71588.98	.41	3p 2D3/2	-	8d 2F5/2
00		1393.462	71763.71	.10*	3p 2D5/2	-	8d 4D7/2
0		1392.348	71821.14	.14	3p 2D5/2	-	8d 2F7/2
00		1391.027	71889.33	8.78	3p 2D5/2	-	9d 4F7/2
00		1384.699	72217.89	8.28	3p 2D5/2	-	9d 2F7/2
6		1381.637	72377.91	8.00	3p 4S3/2	-	5s 4P1/2
7		1381.469	72386.70	.35	3p 4S3/2	-	3d 4P5/2
7		1379.429	72493.75	.81	3p 4S3/2	-	3d 4P3/2
6		1377.937	72572.26	.40	3p 4S3/2	-	5s 4P3/2
6		1377.080	72617.42	.79	3p 4S3/2	-	3d 4P1/2
5		1374.732	72741.42	.81	3p 4S3/2	-	3d 2D3/2
6		1373.500	72806.70	7.20	3p 4S3/2	-	5s 4P5/2
6		1372.033	72884.54	.87	3p 4S3/2	-	3d 2D5/2
2		1370.921	72943.66	.80	3p 4S3/2	-	5s 2P1/2
4		1365.195	73249.61	.81	3p 4S3/2	-	5s 2P3/2
4		1321.427	75675.75	6.09	3p 4S3/2	-	4d 2P3/2
2		1319.020	75813.85	.72	3p 4S3/2	-	4d 2P1/2
1		1318.678	75833.51	.18	3p 4S3/2	-	4d 2F5/2
0		1316.654	75950.11	9.47	3p 4S3/2	-	4d 4F3/2
2		1314.988	76046.34	5.99	3p 4S3/2	-	4d 4F5/2
5	bl	1306.036	76567.55	6.49*	3p 4S3/2	-	4d 4D1/2
4		1305.717	76586.27	5.71	3p 4S3/2	-	4d 4D3/2
3	bl	1305.004	76628.12	7.90*	3p 4S3/2	-	4d 4D5/2
00		1300.225	76909.74	2.25*	3p 4S3/2	-(S)	4s 2S1/2
6		1286.449	77733.36	.68	3p 4S3/2	-	4d 4P5/2
4		1285.862	77768.86	9.50	3p 4S3/2	-	6s 4P1/2
5	bl	1284.805	77832.85	3.75*	3p 4S3/2	-	4d 2D3/2
5		1283.884	77888.67	.81	3p 4S3/2	-	4d 4P3/2
5	bl	1282.980	77943.53	2.55*	3p 4S3/2	-	6s 4P3/2
5		1282.921	77947.10	6.70*	3p 4S3/2	-	4d 2D5/2
5		1282.624	77965.16	.52	3p 4S3/2	-	4d 4P1/2
1		1281.246	78049.02	.07	3p 4S3/2	-	6s 2P1/2
3		1278.593	78210.99	1.34	3p 4S3/2	-	6s 4P5/2
2		1276.498	78339.35	.84	3p 4S3/2	-(D)	3d 2F5/2
3		1276.186	78358.45	.79	3p 4S3/2	-	6s 2P3/2
3		1263.869	79122.12	.19	3p 4S3/2	-	5d 2P3/2
1		1262.311	79219.80	.56	3p 4S3/2	-	5d 2P1/2
0		1260.422	79338.51	9.38*	3p 4S3/2	-	5d 4F3/2
3		1259.413	79402.07	.10	3p 4S3/2	-	5d 4F5/2
1		1254.758	79696.66	.59	3p 4S3/2	-	5d 4D1/2
3		1254.412	79718.64	.49	3p 4S3/2	-	5d 4D3/2
4		1253.737	79761.56	.77	3p 4S3/2	-	5d 4D5/2

2		1247.142	80183.35	.29	3p	4S3/2	-	5d 2F5/2
2		1246.566	80220.35	.46	3p	4S3/2	-	7s 4P1/2
2		1245.334	80299.74	.41	3p	4S3/2	-	5d 2D3/2
4		1245.193	80308.85	.41	3p	4S3/2	-	5d 4P5/2
2		1244.199	80373.01	2.65	3p	4S3/2	-	7s 2P1/2
2		1244.089	80380.09	.49	3p	4S3/2	-	7s 4P3/2
4		1243.374	80426.32	.27	3p	4S3/2	-	5d 4P3/2
3		1242.111	80508.10	.15	3p	4S3/2	-	5d 4P1/2
3		1241.972	80517.10	.05	3p	4S3/2	-	5d 2D5/2
3		1241.475	80549.35	8.77	3p	4S3/2	-(D)3d	2P3/2
0		1239.826	80656.51	5.21*	3p	4S3/2	-(D)3d	2S1/2
00		1239.568	80673.30	2.81	3p	4S3/2	-(D)3d	2P1/2
2		1239.476	80679.23	.30	3p	4S3/2	-	7s 4P5/2
2		1237.470	80810.04	.13	3p	4S3/2	-	7s 2P3/2
0		1233.495	81070.45	9.94	3p	4S3/2	-	6d 4F3/2
2		1232.687	81123.61	.64	3p	4S3/2	-	6d 4F5/2
1		1230.350	81277.71	.27	3p	4S3/2	-	6d 2P3/2
1		1230.251	81284.22	3.84	3p	4S3/2	-	6d 4D1/2
2		1230.062	81296.68	.70	3p	4S3/2	-(D)5s	2D5/2
2		1229.965	81303.09	2.81	3p	4S3/2	-(D)5s	2D3/2
3		1228.465	81402.37	.56	3p	4S3/2	-	6d 4D5/2
2		1228.253	81416.45	5.75	3p	4S3/2	-	6d 4D3/2
0		1226.716	81518.46	6.73*	3p	4S3/2	-	6d 2P1/2
0		1225.825	81577.74	8.64*	3p	4S3/2	-	8s 4P1/2
3		1223.693	81719.81	.54*	3p	4S3/2	-	8s 4P3/2
3				.97*	3p	4S3/2	-	6d 4P5/2
2		1223.017	81765.03	4.68	3p	4S3/2	-	6d 2D3/2
00		1222.963	81768.62	01.28*	3p	4S3/2	-	8s 2P1/2
2		1221.881	81841.03	.73	3p	4S3/2	-	6d 4P3/2
2		1221.150	81890.04	.08	3p	4S3/2	-	6d 2D5/2
2		1221.051	81896.68	.33	3p	4S3/2	-	6d 4P1/2
1		1219.286	82015.21	4.99	3p	4S3/2	-	8s 4P5/2
1		1218.547	82064.95	.43	3p	4S3/2	-	3s 2P3/2
00	d	1218.400	82074.85	5.89*	3p	4S3/2	-	7d 4F3/2
1		1217.852	82111.78	2.37	3p	4S3/2	-	7d 4F5/2
0		1216.602	82196.15	5.77	3p	4S3/2	-(D)3d	2D3/2
0		1216.055	82233.12	.05	3p	4S3/2	-(D)3d	2D5/2
2		1214.389	82345.90	6.23	3p	4S3/2	-	7d 4D5/2
1		1213.965	82374.70	.80	3p	4S3/2	-	7d 2F5/2
00		1211.804	82521.62	.95	3p	4S3/2	-	9s 4P3/2
1		1210.788	82590.81	.22	3p	4S3/2	-	7d 4P5/2
1		1209.706	82664.71	5.31	3p	4S3/2	-	7d 4P3/2
0		1208.617	82739.18	3.86	3p	4S3/2	-	7d 4P1/2
0		1208.430	82752.00	3.31*	3p	4S3/2	-	7d 2D5/2
00		1207.436	82820.12	.60	3p	4S3/2	-	9s 4P5/2
0		1207.113	82842.32	3.16*	3p	4S3/2	-	9s 2P3/2
0		1206.831	82861.66	.77	3p	4S3/2	-	8d 2P3/2
1		1205.647	82943.04	.04	3p	4S3/2	-	8d 4D5/2
0	d	1205.528	82951.20	49.43*	3p	4S3/2	-	8d 2F5/2
1	d	1202.393	83167.50	.15	3p	4S3/2	-	8d 4P5/2

Comments λ(Å)	
2438.643	affected by a PH molecular line
2432.531	affected by a PH molecular line
2075.106	affected by a PH molecular line
1751.799	blended by C I 1751.828 Å
1548.245	blended by P II 1548.225 Å
1532.185	affected by P II 1532.534 Å
1506.984	blended by P II 1506.976 Å
1504.711	blended by a line of unknown origin
1453.	masked by P II 1452.895 Å
1306.036	blended by O I 1306.029 Å
1305.004	blended by P II 1304.997 Å
1284.895	blended by Ar II 1284.793 Å

Table IVa. Unclassified P I lines in the region 4.0-1.0 μm.

Intensity	λ_{air}(Å)	$\sigma(cm^{-1})$
4	33121.947	3018.323
3	32085.117	3115.860
3	32084.747	3115.896
2	28297.839	3532.875
2	28213.674	3543.414
2	28169.346	3548.990
3	27835.337	3591.576
2	27830.323	3592.223
2	27777.139	3599.101
2	27768.984	3600.158
2	27768.768	3600.186
2	27760.008	3601.322
2	27663.858	3613.839
2	27581.963	3624.569
2	25388.570	3937.706
2	20705.340	4828.354
2	20677.700	4834.808
1	19846.719	5037.241
2	19846.562	5037.281
1	18559.088	5386.725
1	18428.080	5425.020
2	18119.314	5517.466
2	15118.756	6612.494
3	15109.310	6616.628
3	15021.579	6655.271
2	14671.176	6814.224

Table IVa continued

1	14671.128	6814.246
3 u	14577.739	6857.900
2 u	14006.161	7137.764
1	13275.824	7530.430
1	12929.853	7731.925
1	12843.580	7783.862
1	12839.362	7786.419
1	12805.028	7807.297
1	12132.585	8240.012
1	12125.883	8244.566
1	12111.460	8254.384
1	11972.955	8349.872
1	11941.539	8371.840
1	11934.241	8376.958

Table IVb. Unclassified P I lines in the region 11500-4000 Å.

Intensity	λ_{air}(Å)	$\sigma(cm^{-1})$
1	11133.11	8979.76
0	10980.83	9104.29
1	10894.11	9176.76
4	10707.33	9336.84
2	9679.90	10329.99
1	9423.03	10609.39
2	9414.13	10619.42
2	9338.68	10705.21
1	9312.70	10735.08
2	9224.99	10837.15

Table IVb continued

2	9211.93	10852.51
2	9208.56	10856.48
3	9208.09	10857.04
3	9191.70	10876.40
4	9189.87	10878.56
6	9185.33	10883.94
1	9140.09	10937.81
2	9137.50	10940.91
0	9130.71	10949.05
8	9121.12	10960.56
1	8783.120	11382.35
1	8627.453	11587.72
2	8232,997	12142.91
2	8222.168	12158.90
1	7939.622	12591.60
1 d	7922.035	12619.55
1	7799.011	12818.61
2 w	7789.141	12834.86
1 w	7377.91	13550.24
2	7293.505	13707.05
1	7270.683	13750.08
2	7202.282	13880.66
1	6772.413	14761.71
2	6769.408	14768.26
3	6741.751	14828.85
2	6733.821	14846.31
1	6726.388	14862.72
2 d	6715.271	14887.32
0	6711.555	14895.57
1	6705.347	14909.36

Table IVb continued

1	6693.008	14936.84
3	6689.285	14945.16
2 w	6663.313	15003.41
2 w	6659.586	15011.80
1	6648.472	15036.90
2 d	6644.775	15045.26
1	6611.982	15119.88
1 d	6554.539	15252.39
3	6545.123	15274.33
3	6543.432	15278.28
1	6497.142	15387.13
3	6420.562	15570.66
2	6312.344	15837.60
1	6265.483	15956.05
1	6259.402	15971.55
1	6215.292	16084.90
3	6193.781	16140.76
2	6149.093	16258.06
1 d	6045.270	16537.28
3	6022.277	16600.42
1	5976.552	16727.42
1 w	5963.130	16765.07
1 d	5833.985	17136.19
1 d	5741.141	17413.31
1	5706.156	17520.07
1	5483.856	18230.28
1	5453.848	18330.58
1	5405.018	18496.18
1	5382.682	18572.93
1	5249.072	18937.45
2	4791.327	20865.21

Table Va. The term system of P I, odd levels.

	Designation	E(cm^{-1})	ΔE(cm^{-1})
Configuration:	$3s^2 3p^3$		
	$^4S_{3/2}$	0.00	
	$^2D_{3/2}$	11361.02	15.61
	$^2D_{5/2}$	11376.63	
	$^2P_{1/2}$	18722.71	25.30
	$^2P_{3/2}$	18748.01	
Configurations:	$3s^2 3p^2(^3P)nl$		
Limits:	$3s^2 3p^2$ $^3P_0$:	84580.83 cm^{-1}	
	$^3P_1$:	84745.73	
	$^3P_2$:	85049.94	
2 [a]	4p $^4S_{3/2}$	66834.648	
1	$^4P_{1/2}$	66343.438	16.844
1	$^4P_{3/2}$	66360.282	183.961
2	$^4P_{5/2}$	66544.243	
1	$^4D_{1/2}$	65373.556	76.569
0	$^4D_{3/2}$	65450.125	135.005
1	$^4D_{5/2}$	65585.130	202.325
2	$^4D_{7/2}$	65788.455	
0	$^2S_{1/2}$	64239.591	

2	$^2P_{1/2}$	67971.072	
			117.004
2	$^2P_{3/2}$	68088.076	
1	$^2D_{3/2}$	66813.271	
			300.599
2	$^2D_{5/2}$	67113.870	
2	5p $^4S_{3/2}$	76021.601	
1	$^4P_{1/2}$	75699.831	
			-10.549
1	$^4P_{3/2}$	75689.282	
			215.830
2	$^4P_{5/2}$	75905.112	
1	$^4D_{1/2}$	75291.257	
			60.255
0	$^4D_{3/2}$	75351.512	
			132.947
1	$^4D_{5/2}$	75484.459	
			221.142
2	$^4D_{7/2}$	75705.601	
0	$^2S_{1/2}$	75104.423	
2	$^2P_{1/2}$	76762.279	
			112.971
2	$^2P_{3/2}$	76875.250	
1	$^2D_{3/2}$	76192.199	
			233.025
2	$^2D_{5/2}$	76425.224	
2	6p $^4S_{3/2}$	79621.43	
1	$^4P_{3/2}$	79297.23	
			264.76
2	$^4P_{5/2}$	79561.99	
1	$^4D_{1/2}$	79129.64	
			-29.52
0	$^4D_{3/2}$	79100.12	
			129.85
1	$^4D_{5/2}$	79229.97	
			254.87
2	$^4D_{7/2}$	79484.84	

0	$^2S_{1/2}$	79044.08	
2	$^2P_{1/2}$	79690.04	140.24
2	$^2P_{3/2}$	79830.28	
1	$^2D_{3/2}$	79415.38	296.03
2	$^2D_{5/2}$	79711.41	
0	4f $(3)_{5/2}$	77654.560	0.755
0	$(3)_{7/2}$	77655.315	
1	$(2)_{3/2}$	77843.316	0.665
1	$(2)_{5/2}$	77843.981	
1	$(3)_{5/2}$	77783.840	0.903
1	$(3)_{7/2}$	77784.743	
1	$(4)_{7/2}$	77831.093	-0.788
1	$(4)_{9/2}$	77830.305	
2	$(1)_{1/2}$	78069.275	-0.165
2	$(1)_{3/2}$	78069.110	
2	$(2)_{3/2}$	78132.673	0.805
2	$(2)_{5/2}$	78133.478	
2	$(3)_{5/2}$	78170.285	-0.315
2	$(3)_{7/2}$	78169.970	
2	$(4)_{7/2}$	78179.687	-1.633
2	$(4)_{9/2}$	78178.054	
2	$(5)_{9/2}$	78102.997	-2.103
2	$(5)_{11/2}$	78100.894	
0	5f $(3)_{5/2}$	80154.30	0.58
0	$(3)_{7/2}$	80154.88	

1	$(2)_{3/2}$	80334.16	0.69
1	$(2)_{5/2}$	80334.85	
1	$(3)_{5/2}$	80299.78	0.67
1	$(3)_{7/2}$	80300.45	
1	$(4)_{7/2}$	80325.43	-0.76
1	$(4)_{9/2}$	80324.67	
2	$(1)_{1/2}$	80594.20	-0.02
2	$(1)_{3/2}$	80594.18	
2	$(2)_{3/2}$	80621.93	0.51
2	$(2)_{5/2}$	80622.44	
2	$(3)_{5/2}$	80643.16	-0.24
2	$(3)_{7/2}$	80642.92	
2	$(4)_{7/2}$	80648.40	-1.26
2	$(4)_{9/2}$	80647.14	
2	$(5)_{9/2}$	80611.16	-1.70
2	$(5)_{11/2}$	80609.46	
0	6f $(3)_{5/2}$	81510.56	0.28
0	$(3)_{7/2}$	81510.84	
1	$(2)_{3/2}$	81684.53	0.54
1	$(2)_{5/2}$	81685.07	
1	$(3)_{5/2}$	81663.75	0.48
1	$(3)_{7/2}$	81664.23	
1	$(4)_{7/2}$	81679.01	-0.57
1	$(4)_{9/2}$	81678.44	
2	(1)	81961.17	
2	$(2)_{3/2}$	81976.76	0.43
2	$(2)_{5/2}$	81977.19	

2		$(3)_{5/2}$	81989.49	-0.18
2		$(3)_{7/2}$	81989.31	
2		$(4)_{7/2}$	81992.78	-0.84
2		$(4)_{9/2}$	81991.94	
2		$(5)_{9/2}$	81971.91	-1.18
2		$(5)_{11/2}$	81970.73	
0	7f	$(3)_{5/2}$	82327.19	0.21
0		$(3)_{7/2}$	82327.40	
1		$(2)_{3/2}$	82498.46	-0.05
1		$(2)_{5/2}$	82498.41	
1		$(3)_{5/2}$	82484.97	-0.02
1		$(3)_{7/2}$	82484.95	
1		$(4)_{7/2}$	82494.33	-0.42
1		$(4)_{9/2}$	82493.91	
2		(1)	82783.04	
2		$(2)_{3/2}$	82795.47	0.38
2		$(2)_{5/2}$	82795.85	
2		$(3)_{5/2}$	82800.84	-0.08
2		$(3)_{7/2}$	82800.76	
2		$(4)_{7/2}$	82803.91	-0.48
2		$(4)_{9/2}$	82803.43	
2		$(5)_{9/2}$	82791.20	-0.81
2		$(5)_{11/2}$	82790.39	
1	8f	$(3)_{5/2}$	83016.31	0.04
1		$(3)_{7/2}$	83016.35	
1		$(4)_{7/2}$	83023.11	-0.29
1		$(4)_{9/2}$	83022.82	

2		$(4)_{9/2}$	83332.04	
2		$(5)_{9/2}$	83322.22	-0.59
2		$(5)_{11/2}$	83321.63	
2	9f	$(4)_{9/2}$	83691.91	
2		$(5)_{11/2}$	83685.48	

Configuration: $3s^2 3p^2 (^1D_2) 4p$

Limit: $3s^2 3p^2\ ^1D_2$: 93463.15 cm^{-1}

	$^2P_{1/2}$	75455.774	33.130
	$^2P_{3/2}$	75488.904	
	$^2D_{3/2}$	74271.699	29.774
	$^2D_{5/2}$	74301.473	
	$^2F_{5/2}$	74717.628	22.158
	$^2F_{7/2}$	74739.786	

Table Vb. even levels

Designation			E(cm^{-1})	$\Delta E(cm^{-1})$

Configurations: $3s^2 3p^2 (^3P) nl$

0	4s	$^4P_{1/2}$	55939.421	151.205
1		$^4P_{3/2}$	56090.626	249.030
2		$^4P_{5/2}$	56339.656	
1		$^2P_{1/2}$	57876.574	297.792
2		$^2P_{3/2}$	58174.366	
0	5s	$^4P_{1/2}$	72378.000	194.400
1		$^4P_{3/2}$	72572.400	234.803
2		$^4P_{5/2}$	72807.203	

1		$^2P_{1/2}$	72943.803	306.003
2		$^2P_{3/2}$	73249.806	
0	6s	$^4P_{1/2}$	77769.50	173.05
1		$^4P_{3/2}$	77942.55	268.79
2		$^4P_{5/2}$	78211.34	
1		$^2P_{1/2}$	78049.07	309.73
2		$^2P_{3/2}$	78358.80	
0	7s	$^4P_{1/2}$	80220.46	160.03
1		$^4P_{3/2}$	80380.49	298.81
2		$^4P_{5/2}$	80679.30	
1		$^2P_{1/2}$	80372.65	437.48
2		$^2P_{3/2}$	80810.13	
0	8s	$^4P_{1/2}$	81578.64	140.90
1		$^4P_{3/2}$	81719.54	295.45
2		$^4P_{5/2}$	82014.99	
1		$^2P_{1/2}$	81771.3	293.1
2		$^2P_{3/2}$	82064.43	
1	9s	$^4P_{3/2}$	82521.95	298.65
2		$^4P_{5/2}$	82820.60	
2		$^2P_{3/2}$	82843.16	
2	3d	$^4P_{1/2}$	72617.789	-123.983
2		$^4P_{3/2}$	72493.806	-107.459
2		$^4P_{5/2}$	72386.347	

1		$^4D_{1/2}$	69878.033	
				16.274
1		$^4D_{3/2}$	69894.307	
				30.146
1		$^4D_{5/2}$	69924.453	
				55.624
2		$^4D_{7/2}$	69980.077	
0		$^4F_{3/2}$	68183.186	
				78.965
0		$^4F_{5/2}$	68262.151	
				115.321
1		$^4F_{7/2}$	68377.472	
				155.181
2		$^4F_{9/2}$	68532.653	
2		$^2P_{1/2}$	68126.607	
				-217.471
1		$^2P_{3/2}$	67909.136	
2		$^2D_{3/2}$	72741.808	
				143.057
2		$^2D_{5/2}$	72884.865	
1		$^2F_{5/2}$	70391.801	
				297.703
2		$^2F_{7/2}$	70689.504	
2	4d	$^4P_{1/2}$	77965.5	
				-76.7
2		$^4P_{3/2}$	77888.81	
				-155.13
2		$^4P_{5/2}$	77733.68	
1		$^4D_{1/2}$	76566.49	
				19.22
1		$^4D_{3/2}$	76585.71	
				42.19
1		$^4D_{5/2}$	76627.90	
				81.52
2		$^4D_{7/2}$	76709.42	
0		$^4F_{3/2}$	75949.47	
				96.52
0		$^4F_{5/2}$	76045.99	
				127.36
1		$^4F_{7/2}$	76173.35	
				144.66
2		$^4F_{9/2}$	76318.01	

2		$^2P_{1/2}$	75813.72	
				-137.63
1		$^2P_{3/2}$	75676.09	
2		$^2D_{3/2}$	77833.75	
				112.95
2		$^2D_{5/2}$	77946.70	
1		$^2F_{5/2}$	75833.18	
				123.69
2		$^2F_{7/2}$	75956.87	
2	5d	$^4P_{1/2}$	80508.15	
				-81.88
2		$^4P_{3/2}$	80426.27	
				-117.86
2		$^4P_{5/2}$	80308.41	
1		$^4D_{1/2}$	79696.59	
				21.90
1		$^4D_{3/2}$	79718.49	
				43.28
1		$^4D_{5/2}$	79761.77	
				101.94
2		$^4D_{7/2}$	79863.71	
0		$^4F_{3/2}$	79339.38	
				62.72
0		$^4F_{5/2}$	79402.10	
				113.25
1		$^4F_{7/2}$	79515.35	
				205.35
2		$^4F_{9/2}$	79720.70	
2		$^2P_{1/2}$	79219.56	
				-97.37
1		$^2P_{3/2}$	79122.19	
2		$^2D_{3/2}$	80299.41	
				217.65
2		$^2D_{5/2}$	80517.06	
1		$^2F_{5/2}$	80183.29	
				277.88
2		$^2F_{7/2}$	80461.17	

2	6d	$^4P_{1/2}$	81896.33	
				-55.60
2		$^4P_{3/2}$	81840.73	
				-120.76
2		$^4P_{5/2}$	81719.97	
1		$^4D_{1/2}$	81283.84	
				131.91
1		$^4D_{3/2}$	81415.75	
				-13.19
1		$^4D_{5/2}$	81402.56	
				131.76
2		$^4D_{7/2}$	81534.32	
0		$^4F_{3/2}$	81069.94	
				53.70
0		$^4F_{5/2}$	81123.64	
				110.12
1		$^4F_{7/2}$	81233.76	
				233.96
2		$^4F_{9/2}$	81467.72	
2		$^2P_{1/2}$	81516.73	
				-239.46
1		$^2P_{3/2}$	81277.27	
2		$^2D_{3/2}$	81764.68	
				125.40
2		$^2D_{5/2}$	81890.08	
1		$^2F_{5/2}$	81522.20	
				272.91
2		$^2F_{7/2}$	81795.11	
2	7d	$^4P_{1/2}$	82738.86	
				-73.55
2		$^4P_{3/2}$	82665.31	
				-75.09
2		$^4P_{5/2}$	82590.22	
1		$^4D_{5/2}$	82346.23	
				168.65
2		$^4D_{7/2}$	82514.88	
0		$^4F_{3/2}$	82075.89	
				36.48
0		$^4F_{5/2}$	82112.37	
				111.78
1		$^4F_{7/2}$	82224.15	
				254.91
2		$^4F_{9/2}$	82479.06	

1		$^2P_{3/2}$	82251.36	
2		$^2D_{5/2}$	82753.31	
1		$^2F_{5/2}$	82374.80	265.61
2		$^2F_{7/2}$	82640.41	
2	8d	$^4P_{5/2}$	83167.15	
1		$^4D_{5/2}$	82943.04	193.69
2		$^4D_{7/2}$	83136.73	
0		$^4F_{3/2}$	82689.80	44.60
0		$^4F_{5/2}$	82734.40	112.51
1		$^4F_{7/2}$	82846.91	268.99
2		$^4F_{9/2}$	83115.90	
1		$^2P_{3/2}$	82861.8	
1		$^2F_{5/2}$	82949.43	248.33
2		$^2F_{7/2}$	83197.76	
2	9d	$^4D_{7/2}$	83555.24	
1		$^4F_{7/2}$	83265.41	277.18
2		$^4F_{9/2}$	83542.59	
2		$^2F_{7/2}$	83594.91	
0	6g	$(4)_{7/2}$	81527.562	.034
0		$(4)_{9/2}$	81527.596	
1		$(4)_{7/2}$	81687.072	.015
1		$(4)_{9/2}$	81687.087	
1		$(5)_{9/2}$	81694.358	-.001
1		$(5)_{11/2}$	81694.357	

2	$(4)_{7/2}$	81997.273	.113
2	$(4)_{9/2}$	81997.386	
2	$(5)_{9/2}$	82001.933	-.011
2	$(5)_{11/2}$	82001.922	
2	$(6)_{11/2}$	81992.728	-.001
2	$(6)_{13/2}$	81992.727	

Configurations: $3s^2 3p^2 (^1D_2) nl$

4s	$^2D_{3/2}$	65156.242	.884
	$^2D_{5/2}$	65157.126	
5s	$^2D_{3/2}$	81302.81	-6.11
	$^2D_{5/2}$	81296.70	
3d	$^2S_{1/2}$	80655.21	
	$^2P_{1/2}$	80672.81	-124.04
	$^2P_{3/2}$	80548.77	
	$^2D_{3/2}$	82195.77	37.28
	$^2D_{5/2}$	82233.05	
	$^2F_{5/2}$	78339.84	89.47
	$^2F_{7/2}$	78429.31	
	$^2G_{7/2}$	78579.96	-14.86
	$^2G_{9/2}$	78565.10	

Configuration: $3s^2 3p^2 (^1S_0) 4s$

Limit: $3s^2 3p^2\ ^1S_0$: 106156.45 cm^{-1}

	$^2S_{1/2}$	76912.25

Configuration: $3s3p^4$

$^4P_{1/2}$	59820.371	
		-104.450
$^4P_{3/2}$	59715.921	
		181.372
$^4P_{5/2}$	59534.549	
$^2D_{3/2}$	71202.979	
		-34.750
$^2D_{5/2}$	71168.229	

a) The figures in this column are the J-values of the limit levels in P II.

Table VI. Corrections applied to the FTS wavenumbers for different configurations.

	Conf	Corr (cm^{-1})
(^3P)	4s	0.003
	5s	-0.002
	4p	-0.001
	5p	-0.013
	6p	-0.015
	3d	0.008
	4d	-0.017
	5d	-0.018
	4f	-0.010
	sp^4	0.006
(^1D)	4s	-0.011
	5s	-0.016
	4p	-0.012
	3d	-0.028

Table VII. Calculated energy values and percentage composition for the observed levels of the 3d, 4d, 5d and sp^4 configurations.

J	E(obs) cm^{-1}	E(calc) cm^{-1}	o.-c.	Percentage composition
0.5	59820	59838	-18	76% $sp^4\ ^4P$ + 20% $3d\ ^4P$ + 3% $4d\ ^4P$
	68127	67935	192	93% $3d\ ^2P$ + 4% $sp^4\ ^2P$ + 2% $4d\ ^2P$
	69878	69813	65	94% $3d\ ^4D$ + 4% $4d\ ^4D$ + 1% $5d\ ^4D$
	72618	71704	(914)[a]	74% $3d\ ^4P$ + 13% $sp^4\ ^4P$ +11% $4d\ ^4P$
	75814	75857	-43	90% $4d\ ^2P$ + 3% $3d\ ^2P$ + 2% $4d\ ^4D$
	76566	76563	3	93% $4d\ ^4D$ + 4% $3d\ ^4D$ + 2% $4d\ ^2P$
	80655	77406	(1249)[b]	59%(^1D)$3d\ ^2S$+ 32% $sp^4\ ^2S$ + 8%(^1D)$4d\ ^2S$
	77965	77928	37	79% $4d\ ^4P$ + 12% $5d\ ^4P$ + 5% $sp^4\ ^4P$
	79220	79274	-54	83% $5d\ ^2P$ + 9%(^1D)$3d\ ^2P$+ 4% $5d\ ^4D$
	79697	79734	-37	93% $5d\ ^4D$ + 3% $5d\ ^2P$ + 1%(^1D)$3d\ ^2P$
	80508	80478	30	79% $5d\ ^4P$ + 6% $4d\ ^4P$ + 6% $sp^4\ ^4P$
	80673	80602	-71	82%(^1D)$3d\ ^2P$+ 10% $5d\ ^2P$ + 5% $5d\ ^4P$
		92632		54% $sp^4\ ^2S$ + 20%(^1D)$5d\ ^2S$+15%(^1D)$4d\ ^2S$
		97953		93% $sp^4\ ^2P$ + 3% $3d\ ^2P$ + 3% $4d\ ^2P$
1.5	59716	59710	6	76% $sp^4\ ^4P$ + 20% $3d\ ^4P$ + 3% $4d\ ^4P$
	67909	67695	214	92% $3d\ ^2P$ + 4% $sp^4\ ^2P$ + 1% $4d\ ^2P$
	68183	68280	-97	96% $3d\ ^4F$ + 2% $4d\ ^4F$ + 1% $5d\ ^4F$
	69894	69832	62	93% $3d\ ^4D$ + 4% $4d\ ^4D$ + 1% $5d\ ^4D$
	71203	71371	-168	45% $sp^4\ ^2D$ + 36%(^1D)$3d\ ^2D$+ 7% $3d\ ^4P$
	72494	71636	(858)[a]	66% $3d\ ^4P$ + 12% $sp^4\ ^4P$ +10% $4d\ ^4P$
	72742	72825	-83	95% $3d\ ^2D$ + 2% $4d\ ^2D$ + 2% $sp^4\ ^2D$

J	E(obs) cm^{-1}	E(calc) cm^{-1}	o.-c.	Percentage composition
	75676	75691	-15	91% $4d\ ^2P$ + 3% $3d\ ^2P$ + 2% $sp^4\ ^2P$
	75950	75925	24	95% $4d\ ^4F$ + 2% $3d\ ^4F$ + 2% $4d\ ^4D$
	76586	76581	5	92% $4d\ ^4D$ + 4% $3d\ ^4D$ + 2% $4d\ ^4F$
	77834	77829	5	54% $4d\ ^2D$ + 35% $4d\ ^4P$ + 5% $5d\ ^4P$
	77889	77887	2	47% $4d\ ^4P$ + 40% $4d\ ^2D$ + 7% $5d\ ^4D$
	79122	79138	-16	85% $5d\ ^2P$ + 6% $(^1D)3d\ ^2P$ + 2% $4d\ ^2P$
	79339	79317	22	94% $5d\ ^4F$ + 3% $3d\ ^4D$ + 2% $5d\ ^2P$
	79718	79743	-25	91% $5d\ ^4D$ + 3% $5d\ ^4F$ + 2% $5d\ ^4P$
	80299	80238	61	94% $5d\ ^2P$ + 2% $(^1D)3d\ ^2P$ + 1% $5d\ ^4F$
	80426	80413	13	77% $5d\ ^4P$ + 6% $(^1D)3d\ ^2P$ + 6% $4d\ ^4P$
	80548	80617	-68	82% $(^1D)3d\ ^2P$ + 8% $5d\ ^2P$ + 5% $5d\ ^4P$
	82196	82161	35	47% $(^1D)3d\ ^2D$ + 31% $(^1D)4d\ ^2D$ + 17% $sp^4\ ^2D$
		97679		92% $sp^4\ ^2P$ + 3% $3d\ ^2P$ + 3% $4d\ ^2P$
2.5	59535	59487	48	76% $sp^4\ ^4P$ + 20% $3d\ ^4P$ + 3% $4d\ ^4P$
	68262	68376	-114	96% $3d\ ^4F$ + 2% $4d\ ^4F$ + 1% $3d\ ^4D$
	69924	69871	53	91% $3d\ ^4D$ + 4% $4d\ ^4D$ + 2% $3d\ ^2F$
	70392	70295	97	93% $3d\ ^2F$ + 4% $(^1D)3d\ ^2F$ + 2% $3d\ ^4D$
	71168	71209	-41	32% $sp^4\ ^2D$ + 28% $3d\ ^4P$ + 25% $(^1D)3d\ ^2D$
	72386	71586	(800)[a]	45% $3d\ ^4P$ + 17% $sp^4\ ^2D$ + 13% $(^1D)3d\ ^2D$
	72885	72984	-99	91% $3d\ ^2D$ + 3% $sp^4\ ^2D$ + 2% $(^1D)3d\ ^2D$
	75833	75862	-29	48% $4d\ ^2F$ + 29% $(^1D)3d\ ^2F$ + 18% $4d\ ^4F$
	76046	76035	11	75% $4d\ ^4F$ + 11% $4d\ ^2F$ + 7% $(^1D)3d\ ^2F$
	76628	76624	4	89% $4d\ ^4D$ + 4% $4d\ ^4F$ + 4% $3d\ ^4D$
	77734	77702	31	72% $4d\ ^4P$ + 11% $5d\ ^4P$ + 7% $4d\ ^2D$
	77947	77975	-28	86% $4d\ ^2D$ + 6% $4d\ ^4P$ + 2% $(^1D)3d\ ^2F$
	78340	78380	-40	36% $(^1D)3d\ ^2F$ + 35% $4d\ ^2F$ + 22% $5d\ ^2F$

J	E(obs) cm^{-1}	E(calc) cm^{-1}	o.-c.	Percentage composition
2.5	79402	79379	23	90% $5d\ ^4F$ + 8% $5d\ ^4D$ + 1% $3d\ ^4F$
	79762	79776	-14	82% $5d\ ^4D$ + 8% $5d\ ^4F$ + 5% $5d\ ^4P$
	80183	80217	-34	54% $5d\ ^2D$ + 16% $5d\ ^2F$ + 15% $5d\ ^4P$
	80308	80322	-14	56% $5d\ ^4P$ + 20% $5d\ ^2F$ + 6% $(^1D)3d\ ^2F$
	80517	80461	56	39% $5d\ ^2D$ + 39% $5d\ ^2F$ + 10% $(^1D)3d\ ^2F$
	82233	82162	71	47% $(^1D)3d\ ^2D$ + 31% $(^1D)4d\ ^2D$ + 17% $sp^4\ ^2D$
3.5	68377	68519	-142	96% $3d\ ^4F$ + 2% $4d\ ^4F$ + 1% $3d\ ^4D$
	69980	69948	32	91% $3d\ ^4D$ + 4% $4d\ ^4D$ + 3% $3d\ ^2F$
	70690	70650	39	92% $3d\ ^2F$ + 3% $(^1D)3d\ ^2F$ + 3% $3d\ ^4D$
	75957	75987	-30	41% $4d\ ^2F$ + 31% $(^1D)3d\ ^2F$ + 22% $4d\ ^4F$
	76173	76169	4	70% $4d\ ^4F$ + 12% $4d\ ^2F$ + 11% $(^1D)3d\ ^2F$
	76709	76707	2	90% $4d\ ^4D$ + 5% $4d\ ^4F$ + 4% $3d\ ^4D$
	78429	78477	-48	36% $(^1D)3d\ ^2G$ + 27% $4d\ ^2F$ + 23% $(^1D)3d\ ^2F$
	78580	78565	15	60% $(^1D)3d\ ^2G$ + 16% $4d\ ^2F$ + 12% $(^1D)3d\ ^2F$
	79515	79487	29	88% $5d\ ^4F$ + 10% $5d\ ^4D$ + 1% $3d\ ^4F$
	79864	79875	-11	87% $5d\ ^4D$ + 11% $5d\ ^4F$ + 1% $3d\ ^4D$
	80461	80555	-94	77% $5d\ ^2F$ + 17% $(^1D)3d\ ^2F$ + 3% $4d\ ^2F$
4.5	68533	68718	-185	97% $3d\ ^4F$ + 2% $4d\ ^4F$ + 1% $5d\ ^4F$
	76318	76313	5	97% $4d\ ^4F$ + 2% $3d\ ^4F$
	78565	78532	33	96% $(^1D)3d\ ^2G$ + 3% $(^1D)4d\ ^2G$ + 1% $(^1D)5d\ ^2G$
	79721	79671	50	99% $5d\ ^4F$ + 1% $3d\ ^4F$

a) The level values of the term $3d^4P$ were not included in the least squares fit (see text).

b) The value of the level $(^1D)3d\ ^2S_{1/2}$, used in the parameter fit (77500 cm^{-1}), was the observed value (80655 cm^{-1}) subtracted with 1150 cm^{-1} for the calculated perturbation $(^1D)3d\ ^2S_{1/2} \longleftrightarrow (^1S)4s\ ^2S_{1/2}$.

TABLE VIII. Fitted parameter and Hartree-Fock (HF) values (in cm^{-1}) of the configuration (sp^4+3d+4d+5d).

Parameter	Fitted value	HF value	Fitted/HF
3d			
E_{av}	77865±48		
$F_2(p,p)$	1437±10	1877	0.77
$F_2(p,d)$	207± 5	142	1.46
$G_1(p,d)$	219± 7	220	1.00
$G_3(p,d)$	8 fix	8	
ζ_{3p}	366±60	277	1.32
4d			
E_{av}	84189±38		
$F_2(p,p)$	1450 fix	1881	
$F_2(p.d)$	62± 5	64	0.97
$G_1(p,d)$	128± 9	120	1.07
$G_3(p,d)$	4.2 fix	4.2	
ζ_{3p}	319±73	277	1.15
5d			
E_{av}	87086±39		
$F_2(p,p)$	1450 fix	1876	
$F_2(p,d)$	34± 5	35	0.97
$G_2(p,d)$	47± 7	66	0.71
$G_3(p,d)$	2.0 fix	2.0	
ζ_{3p}	288±67	277	1.04

sp^4			
E_{av}	100133±1067		
$F_2(p,p)$	853± 38	1693	0.50
$G_1(s,p)$	10851± 380	20087	0.54
ζ_{3p}	287± 109	233	1.23
Interaction parameters			
$R^1(sp^4,3d)$	11107±187	13272	0.84
$R^1(sp^4,4d)$	7722±325	9870	0.78
$R^1(sp^4,5d)$	5230±338	7305	0.72
$R^1(3d,4d)$	2773±155	2429	1.14
$R^3(3d,4d)$	1100 fix	1388	
$R^1(3d,5d)$	2157±155	1801	1.20
$R^3(3d,5d)$	800 fix	1029	

Total number of fitted levels: 62

Total number of parameters: 22 adjustable and 7 fixed.

Table IXa. The matrix of $^2P_{3/2}$ in $(sp^4+(^1D)3d+(^3P)nd)$. The energy values are expressed in cm^{-1}.

		1 sp^4	2 $(^1D)3d$	3 3d	4 4d	5 5d	6 6d	7 7d	8 8d
1	sp^4	95780							
2	$(^1D)3d$		80427						
3	3d	5235		68870					
4	4d	3640	700		76270				
5	5d	2465	535			79430			
6	6d	1670	410				81195		
7	7d	1130	316					82205	
8	8d	765	243						82845

Table IXb. The calculated level values and a comparison with the experimental values.

Designation	3d	4d	5d	$(^1D)3d$	6d	7d	8d	sp^4
Calculated values (C:)	67797	75537	79001	80480	81234	82186	82835	97951
Exp. values (E.)	67909	75676	79122	80549	81277	82251	82862	
The difference C.-E.	-112	-139	-121	-69	-43	-67	-27	

Table IXc. Coefficients of the new eigenvectors in a representation where the eigenfunctions of the unperturbed positions constitute the base.

		$(^3P)3d$	$(^3P)4d$	$(^3P)5d$	$(^1D)3d$	$(^3P)6d$	$(^3P)7d$	$(^3P)8d$	sp^4
(The base)		67797	75537	79001	80480	81234	82186	82835	97952
	↓								
sp^4	95780	-.20	.16	.09	.02	.09	-.06	.04	-.95
$(^1D)3d$	80427	-.01	.16	.30	-.81	-.44	.15	.09	-.01
$(^3P)3d$	68870	.97	.13	.05	.01	.04	-.02	-.02	-.17
$(^3P)4d$	76270	.09	-.95	.20	-.12	.00	-.02	-.01	-.16
$(^3P)5d$	79430	.04	-.12	-.91	-.36	-.11	-.02	-.02	-.03
$(^3P)6d$	81195	.03	-.06	-.13	.41	-.89	-.04	-.02	-.10
$(^3P)7d$	82205	.02	-.03	-.06	.13	.04	.98	-.03	-.07
$(^3P)8d$	82845	.01	-.02	-.04	.08	.02	.01	.99	-.05

Table X. Observed intensities of the transitions 4p - nd ^2P

4p →		$^2S_{1/2}$	$^2P_{1/2}$	3/2	$^2D_{3/2}$	5/2	$^4S_{3/2}$	$^4P_{1/2}$	3/2	5/2	$^4D_{1/2}$	3/2
3d	$^2P_{3/2}$	19.4[f]										
	1/2	10.8[f]										
4	3/2	14	4.9[f]	0.6[f]		1.9[f]			2		2	
	1/2	12	13.3[f]	5.3[f]								
5	3/2	10	0	1		3			1		1	
	1/2	7	00	00	2		1				0	0
6	3/2	1	2	1					1	1		1
	1/2	2	1	0				2			00	
7	3/2	0	0	1	1		0		1			

[f] indicates that the line is measured in the fourier transform spectrometer.

TABLE XI. The result of the calculation by Cowans' least squares fit program for the (^{3}P) nf configurations. The parameters are given in cm^{-1}.

	4 f	5 f	6 f	7 f
ζ_p	310	310	310	310
F^2(3p nf)	404	206	120	76
$n^3 \times F^2$(3p nf)	25.856	25.750	25.920	26.068
G^2(3p, nf)	11	8	5	2
$n^3 \times G^2$(3p nf)	704	1.000	1.080	686
The mean deviation for the 18 levels of each conf. $\lvert E_{obs} - E_{calc} \rvert$	0.8	0.5	0.3	0.7
Average purity in the JK scheme	98.4%	99.3%	99.5%	99.8%

TABLE XII. Observed intensities in the 4f-6g transition array illustrating the JK pair coupling condition.

		($^3P_2$) 6g						($^3P_1$) 6g				($^3P_0$) 6g	
	K=	6		5		4		5		4		4	
	J=	$13/2$	$11/2$	$11/2$	$9/2$	$9/2$	$7/2$	$11/2$	$9/2$	$9/2$	$7/2$	$9/2$	$7/2$
K	J												
$^3P_2$)4f													
5	$11/2$		2										
	$9/2$			2									
4	$9/2$				1								
	$7/2$					1							
3	$7/2$						3						
	$5/2$							2					
$^3P_1$)4f													
4	$9/2$								2				
	$7/2$									1			
3	$7/2$										2		
	$5/2$											1	
$^3P_0$)4f													
3	$7/2$											2	
	$5/2$												2

Table XIII. The deviations $E_{obs}-E_{calc}$ (in cm^{-1}) when the the two-parameter Ritz formula is applied to the $(^3P)nf$-series and the four-parameter formula to the nd-series and the ns-series.

a. $(^3P_2)nf(5)11/2$: $n - n^* = 0.033568 - 0.117015t$

b. $(^3P_2)nf(5)9/2$: $n - n^* = 0.031998 - 0.101790t$

c. $(^3P_2)nd\ ^4F_{9/2}$: $n - n^* = 0.468945 - 0.051045t - 2.148558t^2 - 7.344823t^3$

d. $(^3P_2)nd\ ^4F_{9/2}$: $n - n^* = 0.472970 - 0.245256t - 1.234893t^2 - 12.169250t^3$

e. $(^3P_2)ns\ ^4P_{5/2}$: $n - n^* = 1.984785 + 0.104391t + 1.034235t^2 - 2.114041t^3$

n	a.	b.	c.	d.	e.
3				0.00	
4	0.00	0.00	0.01	0.00	0.01
5	0.00	0.00	0.01	0.01	0.00
6	0.00	0.00	0.01	0.01	0.01
7	0.02	0.01	0.00	0.06	0.01
8	-0.02	-0.01	0.00	0.00	-0.53
9	0.02		(-0.09)	-0.02	0.01
Series limit: 85049	.94	.94	.91	50.70	51.99